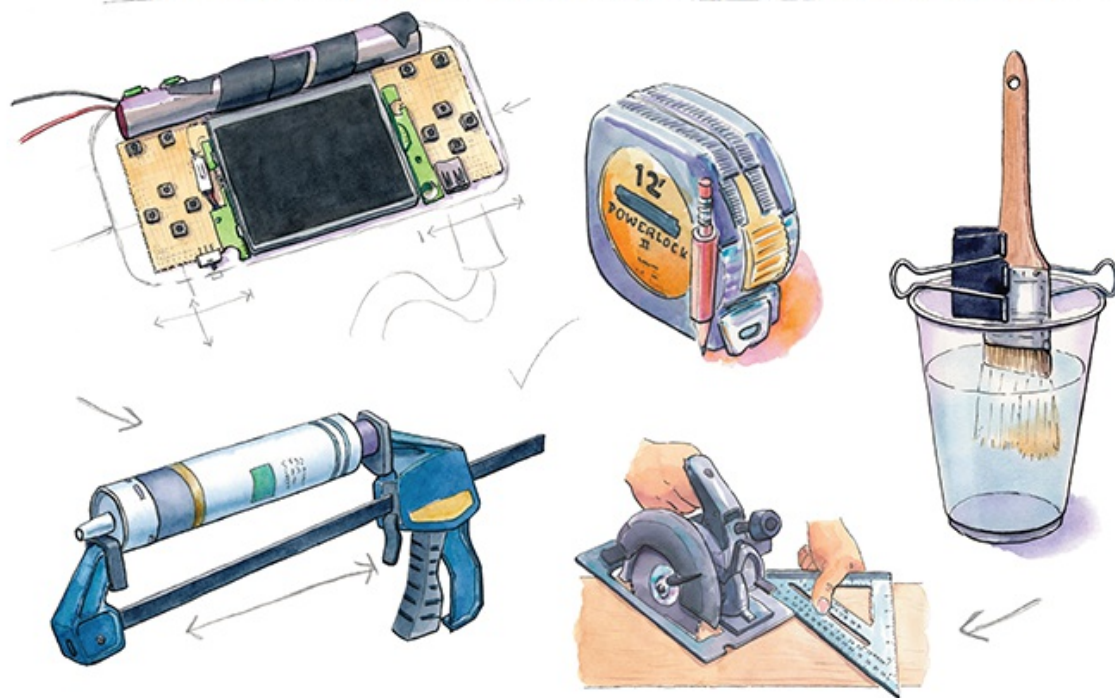


Make:

TIPS AND TALES FROM THE WORKSHOP



A Handy Reference for Makers

Gareth Branwyn

CONTENTS

Titlepage

Praise for Tips and Tales from the Workshop

Copyright

Dedication

About the Author

Foreword

Tips Credits

Acknowledgments

Introduction: How Tools and Shop Tips Often Come with Stories

1: ORGANIZING

2: PROJECT PLANNING

3: MEASURING

4: MARKING

5: CUTTING

6: CLAMPING

7: JOINING

8: GLUING

9: DRILLING

10: FASTENING

11: GENERAL ELECTRONICS

12: SOLDERING

13: MOLDING AND CASTING

14: SANDING AND FINISHING

15: PAINTING

16: SHARPENING

17: DESKTOP FABRICATION (3D PRINTING, CNC, LASER-CUTTING)

18: SEWING

19: TROUBLESHOOTING, MAINTENANCE, AND REPAIR

20: SAFETY AND FIRST AID

21: MISCELLANEOUS

Continuing the Conversation

Index

Make:

TIPS AND TALES FROM THE WORKSHOP

A Handy Reference for Makers

Gareth Branwyn

Foreword by Donald Bell



PRAISE FOR TIPS AND TALES FROM THE WORKSHOP

“Gareth Branwyn is the Tip Master. He scours the workshops of the world for practical, time-saving, life-altering tips to help you make stuff better, faster, and cheaper. This book rounds up the best ones he knows.”

—KEVIN KELLY, creator of Cool Tools and Wired Senior Maverick

“Gareth has essentially created a magic book for makers.”

—Donald Bell, Maker Project Labs

“Tips and Tales from the Workshop is sure to inspire anyone to get making with newfound ease and satisfaction. This book embodies the spirit of great mentors, across every medium, and imparts a wizard-like cleverness to its readers. I thought I was clever, and this book has already prevented at least a dozen new mistakes in my studio. It’s ‘ah-ha’ moment overload!”

—BECKY STERN, DIY guru and Instructables content creator

“It must be hard to write a book like this with such uncommon clarity and in so entertaining a fashion as Gareth Branwyn has done here. Gareth clearly has a deep understanding of making and those who make because he is a maker himself. Tips and Tales from the Workshop is jam packed with invaluable information; it is both a fun read and a reliable shop reference for any do-it-yourselfer.”

—Andy Birkey, YouTube maker

“Tips and Tales from the Workshop is so darned good, I’m kind of mad that Gareth Branwyn didn’t write it decades ago. How

could I have been ignorant all of these years of such tremendously clever and useful tips? One of the best ways to learn is by watching others ply their craft. With its wonderful illustrations, stories, and connections to the past, this book is a bit like being invited to peek over the collective shoulders of generations worth of makers doing what they know and love. This book will have a special place in my workshop, where I'm certain I'll be flipping through it for years to come."

—JOHN PARK, maker at Adafruit Industries, and former host of
Make: TV

Copyright © 2018 Gareth Branwyn. All rights reserved.
Printed in Canada.

Published by
Maker Media, Inc.
1700 Montgomery Street, Suite 240
San Francisco, CA 94111

Maker Media books may be purchased for educational, business, or sales promotional use. Online editions are also available for most titles (safaribooksonline.com). For more information, contact our corporate/institutional sales department: 800-998-9938 or corporate@oreilly.com.

Editorial Director: Roger Stewart
Copy Editor: Elizabeth Campbell, Happenstance Type-O-Rama
Proofreader: Elizabeth Welch, Happenstance Type-O-Rama
Interior and Cover Designer: Maureen Forys, Happenstance Type-O-Rama
Illustrations: Richard Sheppard, Happenstance Type-O-Rama
Indexer: Valerie Perry, Happenstance Type-O-Rama

May 2018: First Edition

Revision History for the First Edition

2018-05-15 First Release

See oreilly.com/catalog/errata.csp?isbn=9781680450798 for release details.

Make:, Maker Shed, and Maker Faire are registered trademarks of Maker Media, Inc. The Maker Media logo is a trademark of Maker Media, Inc. Tips and Tales from the Workshop: An Indispensable Reference with Ingenious Tips, Tricks, and Techniques and related trade dress are trademarks of Maker Media, Inc. Many of the designations used by manufacturers and sellers to distinguish their products are claimed as trademarks. Where those designations appear in this book, and Maker Media, Inc. was aware of a trademark claim, the designations have been printed in caps or initial caps. While the publisher and the author have used good faith efforts to ensure that the information and instructions contained in this work are accurate, the publisher and the author disclaim all responsibility for errors or omissions, including without limitation responsibility for damages resulting from the use of or reliance on this work. Use of the information and instructions contained in this work is at your own risk. If any code samples or other technology this work contains or describes is subject to open source licenses or the intellectual property rights of others, it is your responsibility to ensure that your use thereof complies with such licenses and/or rights.

978-1-68045-079-8

Safari® Books Online

Safari Books Online is an on-demand digital library that delivers expert content in both book and video form from the world's leading authors in technology and business. Technology professionals, software developers, web designers, and business and creative professionals use Safari Books Online as their primary resource for research, problem solving, learning, and certification training. Safari Books Online offers a range of plans and pricing for enterprise, government, education, and individuals. Members have access to thousands of books, training videos, and prepublication manuscripts in one fully searchable database from publishers like O'Reilly Media, Prentice Hall Professional, Addison-Wesley Professional, Microsoft Press, Sams, Que, Peachpit Press, Focal Press, Cisco Press, John Wiley & Sons, Syngress, Morgan Kaufmann, IBM Redbooks, Packt, Adobe Press, FT Press, Apress, Manning, New Riders, McGraw-Hill, Jones & Bartlett, Course Technology, and hundreds more. For more information about Safari Books Online, please visit us online.

How to Contact Us

Please address comments and questions to the publisher:

Maker Media, Inc.
1700 Montgomery Street, Suite 240
San Francisco, CA 94111

You can send comments and questions to us by email at books@makermedia.com.

Maker Media unites, inspires, informs, and entertains a growing community of resourceful people who undertake amazing projects in their backyards, basements, and garages. Maker Media celebrates your right to tweak, hack, and bend any Technology to your will. The Maker Media audience continues to be a growing culture and community that believes in bettering ourselves, our environment, our educational system—our entire world. This is much more than an audience, it's a worldwide movement that Maker Media is leading. We call it the Maker Movement.

To learn more about Make: visit us at make.co. You can learn more about the company at the following websites:

Maker Media: makermedia.com

Maker Faire: makerfaire.com

Maker Shed: makershed.com

Maker Share: makershare.com



To my father, George Maloof, and to his father, Sam: two talented, funny, and kind men who taught me the value of hard work, tinkering, and the joy of making. They also taught me to always maintain a sense of humor no matter what.



ABOUT THE AUTHOR



Gareth Branwyn is a well-known writer and editor, and a pioneer of both online culture and the maker movement. He is the former editorial director of Make: magazine, was a contributing editor to Wired for twelve years, and a senior editor of Boing Boing (in print). He has also contributed to Esquire, Details, I.D., the Baltimore Sun, and numerous other magazines and dailies. In 1993, Gareth collaborated with

Billy Idol on the spoken word lyrics to the opening track on Idol's album, *Cyberpunk*. Gareth is the author and editor of over a dozen books, including the Mosaic Quick Tour for Windows: Accessing & Navigating the Internet's World Wide Web, which was the first book about the World Wide Web, and *The Happy Mutant Handbook* (with the editors of Boing Boing). His last book, *Borg Like Me & Other Tales of Art, Eros, and Embedded Systems*, was a best-of collection and "lazy man's memoir" spanning his over 30-year writing career. Gareth is currently a regular contributor to Make:, Boing Boing, and other online and offline publications.

FOREWORD

I had an English teacher who once told me that to really read a book, you have to write in the margins. To him, reading was interactive, and the books he left in his wake were dense with scribbles and dog-eared pages.

Aside from always keeping a pen on my nightstand, the deeper lesson it taught me is that two people can pick up the same book, watch the same movie, or listen to the same song, but the richness they extract depends on how prepared they are to engage with the work.

Week after week, Gareth and I comb through the internet. My job is to extract DIY projects; his is to gather the best tips, techniques, and clever hacks (like the collection you're holding here). In a sense, we're both writing in the margins of the same book, but from very different perspectives.

Without a doubt, his job is harder because, in their original contexts, these useful little nuggets are often hidden within the project. Within an eight-minute video, Gareth's keen eye can find the 10 seconds featuring some novel technique or tool that the rest of us would miss.

By compiling what he has seen and heard, Gareth has essentially created a magic book for makers. This isn't a book of formal instruction. It's a book of secrets that Gareth found in plain sight. It's a book where you can learn how to blow someone's mind with a zip-tie weave, measure with your fingers, or learn a dozen different techniques for keeping a project notebook. For makers, it's a book full of "Eureka!" moments.

So, read on, write in the margins, dog-ear the good stuff, and pass on what you've learned.

–Donald Bell
Maker Project Lab

TIPS CREDITS

he following handymen and -women were the source for many of the tips in this book. Some of the tips came from project videos or instructional articles that they posted online, some were submitted to me directly, and some came from conversations I had with them.

All of these people are amazing makers and almost all of them have websites and YouTube channels. Do a search. Having all of these people on your radar will yield an ongoing and inspired feed of great shop tips, techniques, and project ideas.

AA = Antron Argaviv

AB = Andy Birkey

AL = Andrew Lewis

AW = April Wilkerson

BD = Bobby Duke

BC = Bob Clagett

BH = Ben Heck

BK = Bob Knetzger

BL = Brad Libby

BL2 = Bill Livolsi

BN = Barb Noren

BS = Becky Stern

CAW= Chris Akiba Wang

CL= Caroline Lewis

CP = Charles Platt

CS = Craig Smith
DB = Donald Bell
DFJ = Dirt Farmer Jay
DN = Dug North
DP = Dave Picciuto
DR = Dustin Roberts
DW = Dale Wheat
FI = Frank Ippolito
GM = Geoff Meston
JB = Jordan Bunker
JB2 = Jay Bates
JD = Jimmy DiResta
JEP = John Edgar Park
JFK = James Floyd Kelly
JN = Jim Newton
JvS = Jake von Slatt
JW = James Wright
KB = Kent Barnes
LB = Lee Bolden
HitD = Hurr it's the Durr
IS = Izzy Swan
LDO = Linn Darbin Orvar
MC = Michael Colombo
MG = Matt Griffin
MG2 = Matthew Gryczan

MO = Michael Overstreet
MSK = Meredith Scheff-King
MV = Miguel Valenzuela
NDB = Niall De Buitlear
NF = Nick Ferry
RH = Ross Hershberger
RS = Reid Schlegel
SH = Scott Haun
SH2 = Steve Hobley
SMR = Sean Michael Ragan
SR = Steve Roberts
SW = Scott Wadsworth
TA = Tim Anderson
TH = Taylor Hill
TS = Tim Slagle
TS2 = Tim Sway
TW = Tyler Winegarner
TW2 = Tilly Walnes
WO = Windell Oskay

ACKNOWLEDGMENTS

hanks to all of the makers who helped inspire this book and to all of those whose tips are featured within its pages. A special thank you to the uber-tippers who were a constant source of clever hacks, tips, how-tos, and bright ideas—Jimmy DiResta, Andy Birkey, Laura Kampf, Donald Bell, Kent Barnes, Bob Clagett, John Edgar Park, Izzy Swan, Leah Bolden, Craig Smith, Bob Knetzger, Sean Michael Ragan, Andrew Lewis—I’m looking at you!

Big thanks to those who allowed me to reprint articles of theirs: Nick Walker, Jordan Bunker, Tim Slagle, Andrew Plumb, Tim Deagan, Tilly Walnes, Andrew Mowry, Michael Overstreet, and Dale Wheat. Also, thanks to everyone who shared stories with me related to tips and tools that appear in sidebars throughout this book. It is your voices that truly helped seasoned this stew.

High-fives to all of the folks at Maker Media, especially my long-suffering publisher, Roger Stewart. And thanks to Maureen Forys, Elizabeth Campbell, Liz Welch, and the folks at Happenstance Type-O-Rama. You were a pleasure to work with. A special shout-out to artist Richard Sheppard who hand-drew and watercolored all of the lovely illustrations that adorn this book. And finally, thanks to Tim Lillis, who let me rerun his “Tricks of the Trade” cartoon that appeared in Make: for many years.

INTRODUCTION:

HOW TOOLS AND SHOP TIPS OFTEN COME WITH STORIES

Tools have always held a special fascination for me. Some of my earliest childhood memories of making are of working beside my grandfather in his basement workshop in Framingham, Massachusetts. He had literally cut into the bedrock beneath his home to create part of it, making it feel like Merlin's lair or the Batcave. It really felt like magic was present, lingering in the air among the smells of dirt, 4-in-1 oil, turpentine, and the 8 O'Clock Coffee cans and baby food jars filled with tools and hardware. There was definitely magic to be found in Grampa's still, which he'd built in the basement for making arak, an anise-based Lebanese hooch. (But that's another story).

One of my other early memories was working beside my dad. He was a general contractor and civil engineer, and I remember riding in a Gradall Excavator with him when I was a wee one. I thought my dad was basically the coolest guy on Earth because he could so confidently pilot such an impressive and intimidating machine. I also remember watching him swing a hammer while he added some rooms to the basement of our home (which he'd also built) and realizing how confident he was in his swing and how it usually took him the same number of swings each time to drive and countersink a nail. I don't know how old I was, but it was probably the first time that I instinctively understood the nobility (and the efficiency) of perfecting a trade-craft.

Tools are an extension of our bodies. Like specialized "end effectors" on a robot, they instantly give us special abilities—superpowers. Combine the right tools, the right materials, and

the proper know-how, and human beings create worlds. Tools are the physical interface between our dreams, our imagination, and their real-world realization. But our tools are not only powerful extensions of ourselves; they are also storytellers.

Two things served as the core inspirations for this book. The first was an old weekly tools column I used to write for the Make: website. Each week I chose a different theme for the column, from exploring various tool types, to shop organization and safety, and even to the clothes and work accessories people wear while working in their shops. One week, the theme was “The Homeliest Tool in the Shed.” The idea was to think about a tool that was so unsexy, so work-a-day dull, that it was nearly invisible to you. “Think of that tool and tell us about it,” we said. We got great entries, from ancient slotted screwdrivers passed down through generations, to beloved ice picks and simple pry bars. I was struck by the fact that almost every submission came with a colorful, sometimes moving story. That’s when I started to think about the idea that so many tools, especially used tools passed down through multiple generations, almost always come with stories attached.

This entry from Make: reader James Vreeland seriously moved me and solidly drove home this point.



“Before the war (WWII), my grandfather was a toolsmith and perpetual tinkerer in Poland. After the fighting started, he and my grandmother were sent to a Siberian work camp. Not content to allow such an inconvenience to keep him from making things, he began cobbling together a humble toolkit. In lieu of a finishing hammer, he was able to scrounge a short piece of round brass bar stock, which over time, mushroomed at both ends and shortened by almost half as he used it. Apparently he found this solution adequate, as when he and my grandmother moved to the States after the war, he continued the practice in his new life as a lamp maker. As each ‘hammer’ got too short to use, he’d toss them into a drawer and begin the process anew. When he passed away, he had ‘finished’ three and was well along his way to completing a fourth. That fourth one I use to this day whenever the need for gentle mechanical persuasion is in called for. Thanks to my

grandfather, Jan Jakiela, for teaching me what patience and dedication look like, in the form of a one-pound lump of metal.”

Even when you don’t know the stories behind these tools, you still imagine that they’re there. Many years ago, I bought a large lot of drafting and engineering design tools at an estate sale in Arlington, VA. The owner had been an engineer working in the aerospace industry. I got a slide rule, drafting templates, Rapidograph pens, lettering tools, a T-square, and the like. I still have them. I still use them. And nearly every time that I do, I wonder about their original owner. What were his life and career like? What projects did he work on? How did he use these tools? For some reason, having gone to that sale, seen his home and home shop, and learned of his profession, I hold a special degree of respect and reverence for these tools. I don’t know what stories they hold, but I can sense they have a few to tell.

The second light bulb moment for this book came during a presentation I did with Jimmy DiResta at Maker Faire Bay Area, 2015. Called “Jimmy DiResta in Conversation with Gareth Branwyn,” it was billed as a relaxed conversation with Jimmy about his backstory, what inspires him, and some of his proudest maker moments. At one point, I decided to ask him to empty his pockets onto the table (I knew he was famous for having overloaded pockets). He didn’t know I was going to ask him to do this, but it almost looked like a scripted comedy bit as he began pulling handful after handful of knives, keys, markers, pencils, notebooks, tape, a flashlight, glasses, and on and on, from everywhere on his person. He had pockets within pockets. In one pocket, he even had a small hi-def video camera that he pulled out, turned on, and placed on the table to record the rest of the talk (upper-right corner of the image).



But it was during a portion of the talk when I asked Jimmy to share some of his favorite shop tips when the other inspiration for the book came. He started off by telling us a story. When he was a young man, he worked in construction with his dad. Every day, as the crew gathered around with their morning coffee, his dad would proclaim, “Tip of the day!”, and then he would share a tip or two. Jimmy said he remembers and uses many of these tips, and he thinks fondly of those “tip of the day” moments when he does.

Jimmy and I started talking about how tips (and tools) are often handed down with stories. I shared the above gem about Jim Vreeland’s grandfather and his handmade brass hammer. After the talk, I thought, “What better, more entertaining, and enriching way to share a fantastic collection of tips with Make: readers than to keep some of their stories attached to them?”

I decided that this book would collect the best shop knowledge that we've shared in the magazine and website over the years and from maker friends around the world. We would leaven all of this with people sharing stories about their shops and tools, projects gone gloriously right or epically wrong, and any words of wisdom passed on to them from parents, teachers, and other mentors.

I tried to write an "Ah-ha" book: one with at least a couple of tips per page that fire neurons in your head, prompting you to write them down, pass them along, or immediately use them. Repetition breeds retention. Circulation generates virality.

When I look at a collection of tips, I judge its usefulness by how many of its revelations become part of my everyday workflow and change how I look at things. I've tried to assemble a collection that has a high chance of progressing far beyond a raised Spockian eyebrow. I hope I have succeeded.

It's always hard to know what basic practices in a discipline are widely known and when a simple trick, fix, or kludge is novel to enough people to include. I think we've found a decent balance. But I'll let you decide. Sometimes, even if you've heard a tip before, it's good to be reminded of it again.

HEY THAT'S MY TIP!

You can't read the comments for many tips videos before someone cries out: "Hey, that's my tip. You stole that from me!" (or something similar).

Tips, like slang, good jokes, and funny memes, yearn to be shared; tips want to be free. They are shared from maker to maker, they are seen being used by people in projects and in videos, and they are added to the arsenal of shop techniques by those exposed to them. They end up in tips articles and books. Tips are promiscuous. And that's a good thing.

I have tried, as much as possible, to at least retain the sources of the tips collected in this book. This attribution is not necessarily the author of the tip, but just the person I got it from. These credits are displayed as initials

at the end of tip entries and there is a list of these contributors in the front of the book. In all cases, the descriptions of the tip (unless quoted) are mine. If I missed any tipsters, I apologize.

★ **MAKING ASSUMPTIONS**

In deciding whom I was talking to in this book, I assumed that the reader is already an avid maker of some stripe and has a basic working knowledge of the tech, terms, and techniques in these tips categories. Acronyms are always unpacked the first time they are used, and when appropriate, tech terms are parenthetically defined. If you find yourself encountering a word or concept that you don't understand, the internet is your on-demand learning machine.

★ **RESOURCES BEYOND THIS BOOK**

I have not bothered to include URLs to web articles, YouTube videos, books, and other resources mentioned in this book. Everything is easily found at the end of a quick web search. In most instances, to make it easier to find what's being discussed, I have included the exact title of the article, video, or how-to being mentioned.

THE TALES THAT BENCHTOPS TELL

Because this book is as much about the people and stories behind its tips and tools, we wanted to do something in the design that reflected that. Since my friend Jimmy DiResta was such a big inspiration for this book, I asked him if he would send me photos of his workbench tops to use as a design element. The background image that opens each chapter and travels across the bottom of each page is taken from one of Jimmy's well-loved, heavily used, clearly abused benches.

With hammer divots, saw marks, drill holes, glue drips, paint oversprays,

and all of the rest of it, a benchtop speaks to the many tools and techniques that have plied its surface. Each preserved mess and mark also has a story to tell about the project that was in progress when that particular indignity was visited upon the bench. Workbenches bear the battle scars of our efforts. Benchtops have stories to tell, too.

Thanks to Jimmy for letting his bench talk to us, and for adding this evocative grace note to my book. I cannot think of a better design element to represent its spirit than a well-worn benchtop from a brilliant and busy maker.

1

ORGANIZING

Results from studies about organization and creativity are all over the map. Some suggest that organization leads to clearer, more productive thinking and creating, while others claim the opposite. You likely already have your own work and organizational style and not much is going to change that. I'm basically a mildly messy person with periodic bursts of organizational energy. For years I beat myself up over my chaotic ways, but then I decided that this was my basic organizational style and that I have still been able to be productive and successful. One thing I've found that helps motivate me to be organized is really clever, thoughtful, and time-saving ideas. Reading a great organizational tip or about some cool organizational technology can inspire a burst of reorganizational energy. Here are a few of my favorite ideas.

★ **START YOUR WEEK ORGANIZED**

One of the few organizational rituals that I have is Sunday cleaning and organizing. I like to start the week with at least some semblance of organization by cleaning up my shop, organizing the papers on my desk, and thinking about what I have ahead for the week. This hour or two each week at least prevents the chaos around me from becoming too unmanageable.

★ **ORGANIZE FOR FIRST ORDER RETRIEVABILITY**

This can help reduce time to find and get your tools and materials. Arrange your workspace so that the more commonly used the tool or material is, the closer it is to you. Conversely, more occasional tools are farther away. This way, the shop is designed so that you can easily find what you need as you need it. [\[VIA ADAM SAVAGE\]](#)

THE INHIBITING POWER OF PERFECTIONISM

One of my dad's favorite sayings was "The best is the enemy of the good." This refers to the inhibiting power of perfectionism. When I find myself intimidated at the prospect of tackling something that I want to do—something good—I remember these wise words.

—PAUL SPINRAD

★ **CREATE A GRATITUDE LOOP**

This one comes from marketing guru Seth Godin by way of Cool Tools (kk.org/cooltools). If you're speaking at a conference or meeting where a lot of people and organizations were involved in hosting, don't waste your precious presentation time thanking them all. Make a slideshow beforehand of everyone you wish to acknowledge, including their name and title, and run it while everyone is finding their seats. Ask each contributor to send you a picture or arrange to have everyone photographed (depending on your situation). You can make this as fun and clever as you wish.

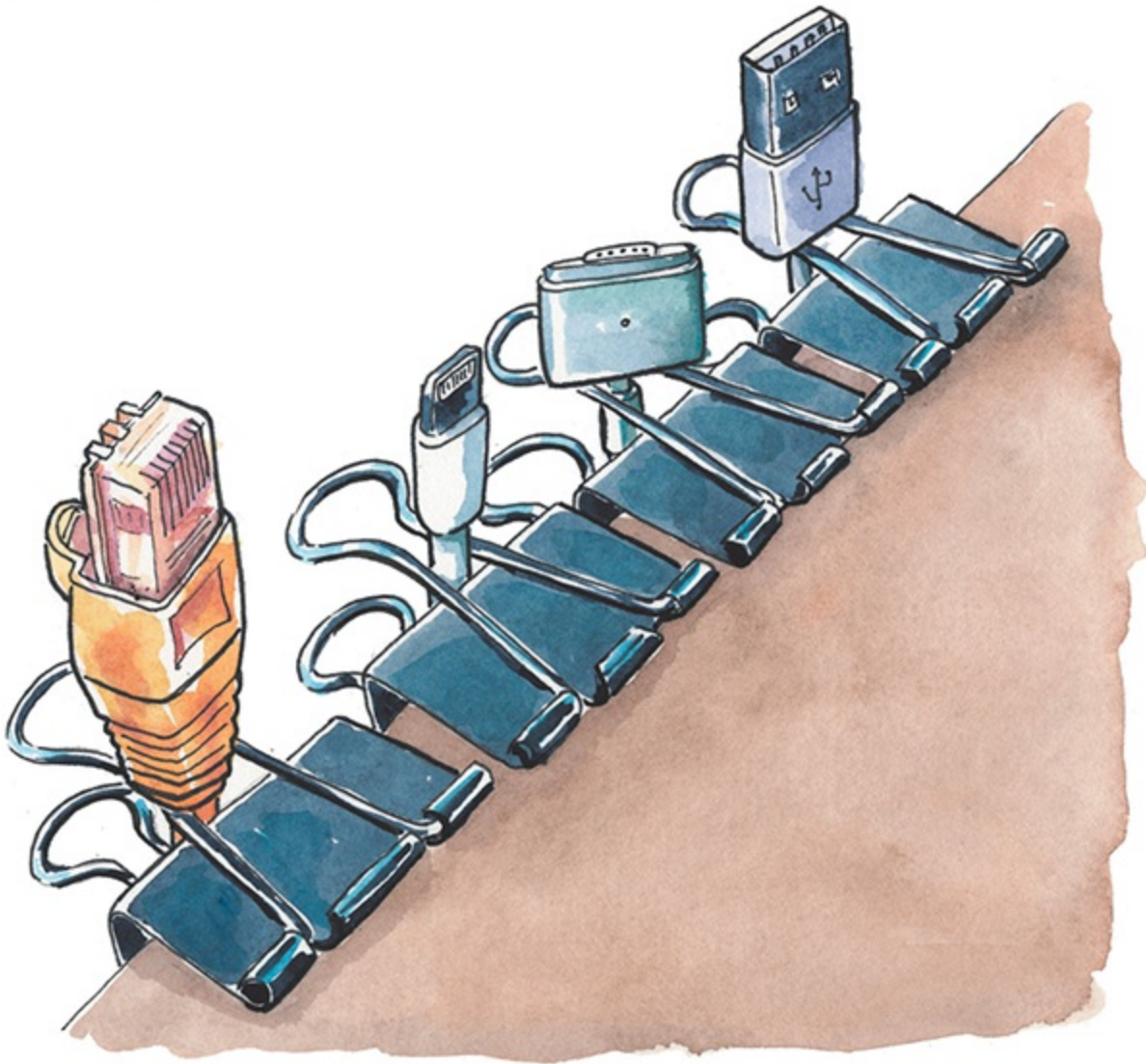
★ **USING EQUIPMENT DEAD SPACE TO YOUR ADVANTAGE**

Jay Bates shared this useful shop organizing tip in one of his YouTube videos. For most of us, shop space is always at a premium. When setting up a shop, you want to carefully think

of the workflow around the machines and how you can optimize operational efficiency and tool and material retrievability. Jay suggests that you plan to use the dead space of each machine (the side that you never interact with) to your advantage by grouping these edges together. [JB]

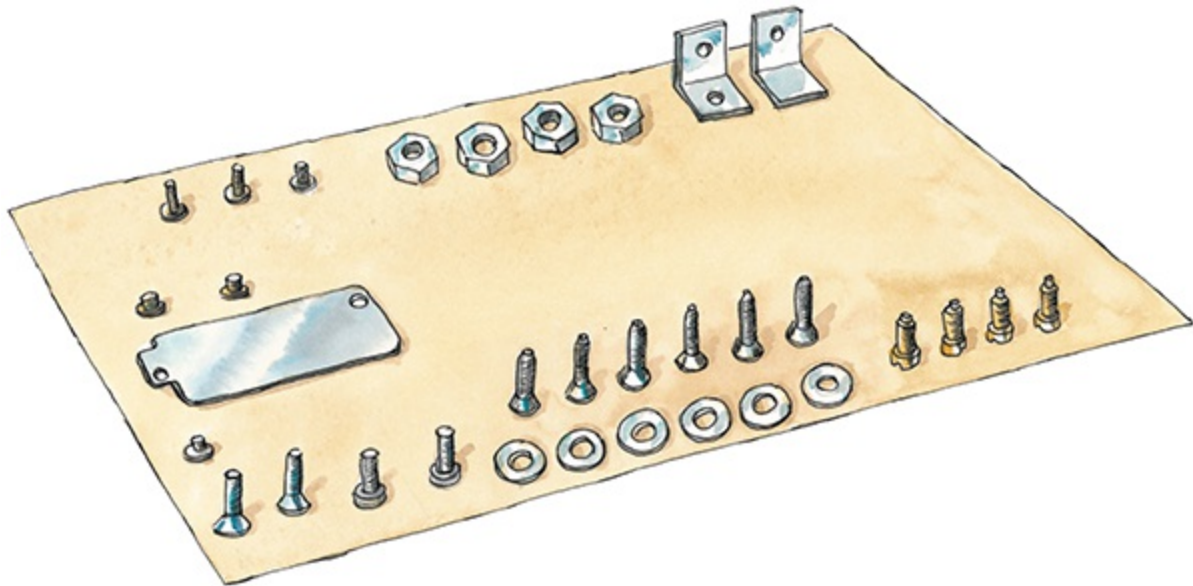
★ **ORGANIZING WITH BINDER CLIPS**

Use a row of binder clips on the edge of your desk as a cable organizer.



★ KEEPING TRACK OF SMALL PARTS

Use double-sided tape to hold small parts in place while you disassemble or reassemble something. Affix the tape to a piece of paper and write where the part goes.



★ PARACHUTE YOUR FASTENERS ONTO THE JOB

To organize your screws and fasteners, consider getting a parachute bag. These are circular, multi-compartment canvas bags that have a cinch-rope top. They can hold a lot, don't take up a lot of space, and are easy to grab and go. Even a really decent, heavy-duty one costs under US\$25 and they will last for many years, even with regular use. [\[SW\]](#)

★ USE SEE-THROUGH BINS FOR SHOP ORGANIZATION

Make: contributor Bill Livolsi suggests using clear bins in your shop to organize your materials, tools, and supplies so that

you can see at a glance what's in them. Bill buys clear plastic shoe boxes and uses those as his storage system. He also recommends organizing items by use rather than material type. So, for instance, everything sanding-related might go into a bin, instead of sandpaper in one, sanding blocks in another, wood putties in another, and so on. [\[BL2\]](#)

★ **LAY OUT YOUR TOOL WALL ON PAPER FIRST**

Miguel Valenzuela, of PancakeBot fame, offers his tip for laying out your tools on a tool wall. "Lay down a piece of construction paper that is the size of the board you will be mounting your tools on. Place the tools on the paper in the arrangement you want. Mark where your support pins, hooks, or screws will be, and then take a picture of your layout. Next, tack the paper to the mounting board and drill away. Before taking the paper off, screw in your mounts. Last, using the picture as a reference, mount all your tools on the wall!" [\[MV\]](#)

★ **MAKING AN EASY FRIDGE MAGNET BATTERY ORGANIZER**

Make: contributor Kent Barnes sent us this idea. He uses the magnetic strip from an old fridge magnet to organize his button cell and coin cell batteries. [\[KB\]](#)



★ COLOR-CODING DRIVERS

Paint the ends of screwdriver handles either red, yellow, or blue, depending on whether they're Phillips, pozidrive, or slotted. Do the same with Allen keys based on whether they're metric or imperial. [AL]

🔧 FIVE LITTLE NOTCHES

My grandfather was handy with tools (weren't they all?). He had a small woodshop and a collection of miscellany that had been acquired through years of working on various machines. At some point he worked on trains; at another, he repaired vacuums.

When you're working in shops with other people, it is always smart to mark your tools so that you know someone else won't end up with them. My grandpa's mark was five little notches or slashes.

I inherited many of grandad's tools when he passed away. They've outlived many of the cheap, modern versions I've acquired during my workshop explorations. Those five marks have become something of a sign of quality in my mind.



Maybe I should begin marking my favorite tools. How would a CNC mill look with five notches on the side?

—CALEB KRAFT

★ ARRANGING TOOLS FOR EASY RETRIEVAL

The always clever and resourceful Dave Hrynkiw of Solarbotics shared this simple gem. To organize your slotted and Phillips head screwdrivers, always make sure to orient them in the drawer with slotted handles facing in one direction and Phillips in the other. Easy. [DH]

★ IDENTIFYING YOUR CABLES

Since so many people have the same chargers, cables, and dongles for phones and laptops, take a second to add an identifying mark or name on your gear. It can be something as simple as colored tape, your initials, or some cool mark or personal brand that you create.

★ LABELING CABLES WITH BREAD TAGS

Here's a tried and true method of cable labeling that I have used for years: plastic bread bag tags as labels.

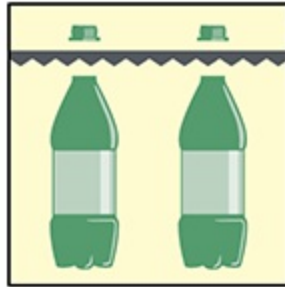


Tricks of the Trade

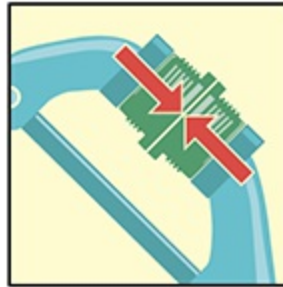
Tim Lillis (narwhalcreative.com)



Here's a great trick to keep small items safe from the elements. Thanks to Brian Green, who originally shared the trick on his backpacking blog at briangreen.net.



Remove the tops of two identical plastic bottles just below the rim near the cap. Sand or file down the excess plastic so that the rim is a clean flange with a flat edge.



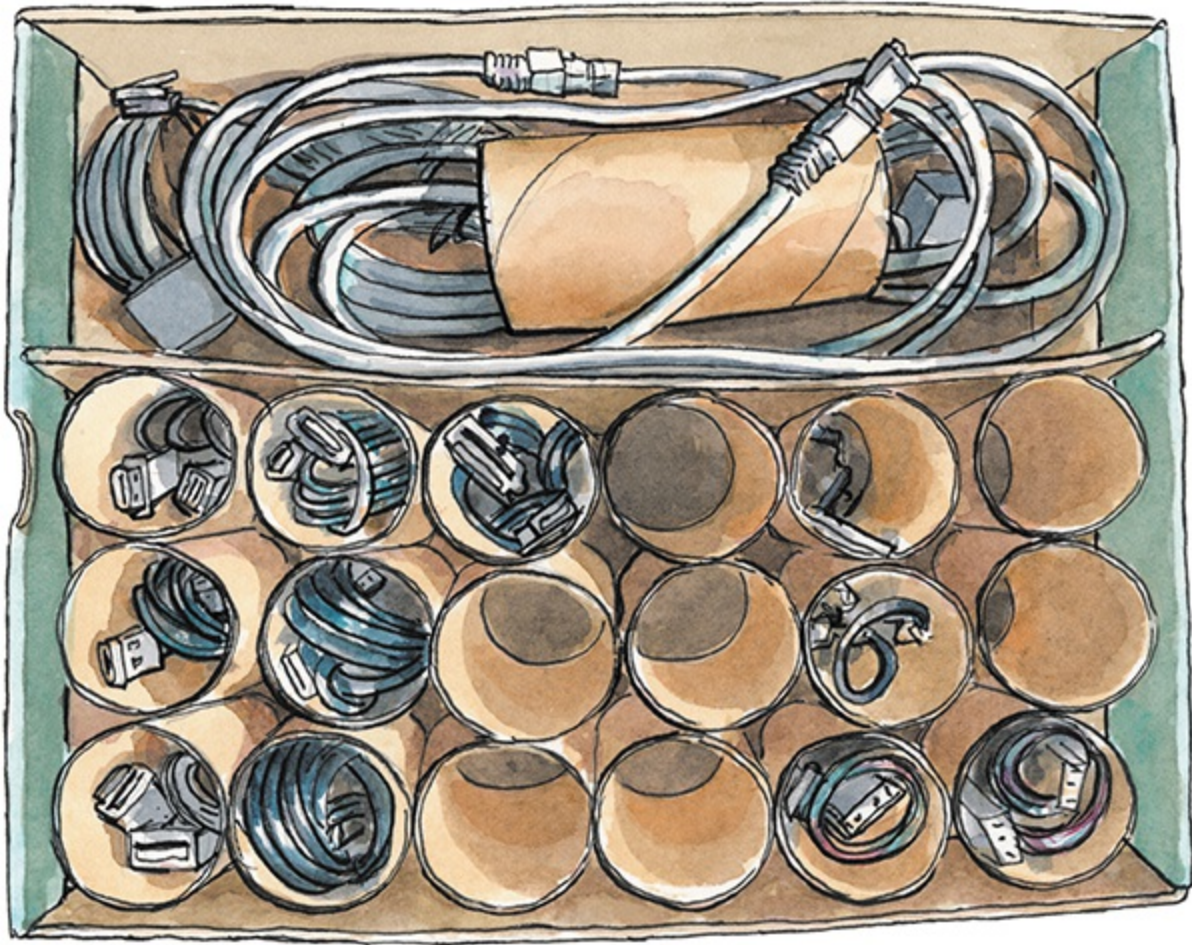
Attach the two bottle tops to each other by placing the flattened flanges together, running a small bead of cyanoacrylate glue in between the parts. Let dry in a clamp or vice.



Place your valuables inside, and screw on the two original soda caps for a waterproof container. To create two compartments, add a thin plastic layer between the two flanges.

★ ORGANIZING CABLES WITH TOILET PAPER TUBES

Use empty toilet paper rolls to hold bundled personal electronics cables and other cords together.



★ USING MAGNETS TO LOCATE A PASS-THROUGH HOLE

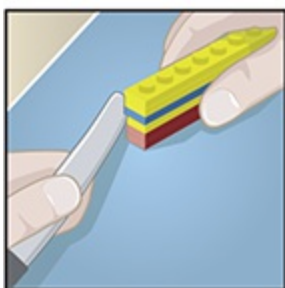
One of my oldest maker friends, Steven Roberts, sent me this little gem for how he makes sure that the cable pass-through holes he's cutting into the cabin of his sailboat are exactly where he wants them to be. "I use a pair of 0.75" diameter N52 neodymium magnets to mark the perfect spot to drill through the cabin wall, since it is easy to measure incorrectly and poke a hole where, oops, damn it, you didn't mean to. All you do is tape a magnet in place on one side of the wall, slap another onto the opposite side of the wall, draw a circle around each magnet, and go from there." Of course, this method only works in situations where you have access to both sides of the wall.

[SR]

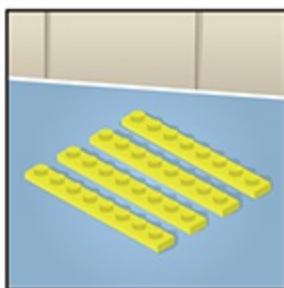
★ USING STRETCH WRAP FOR STRAP ORGANIZING

If you have toe straps and ratchet straps in your shop or in your truck, you can quickly bundle them using stretch wrap. Just use a few loops of wrap and your rolled straps are good to go. You can even reuse the wrap for multiple strap-wrappings. [JD]

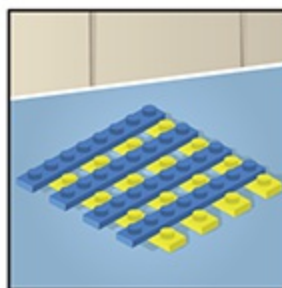
Tricks of the Trade



Are you sick of having piles of disorganized Lego bricks, some randomly placed, some stuck together forever? Evil Mad Scientist Laboratories has you covered.

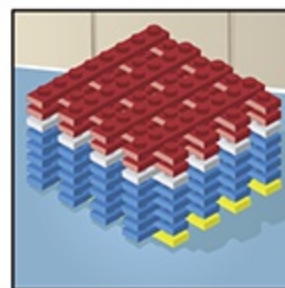


This method works best with 1x6, 1x8, and 1x10 plates. Start by laying a few plates parallel until you have roughly a square shape.



Now lay the same amount on top at a perpendicular angle. You can also take this opportunity to organize your plates by color.

Tim Lillis (narwhalcreative.com)



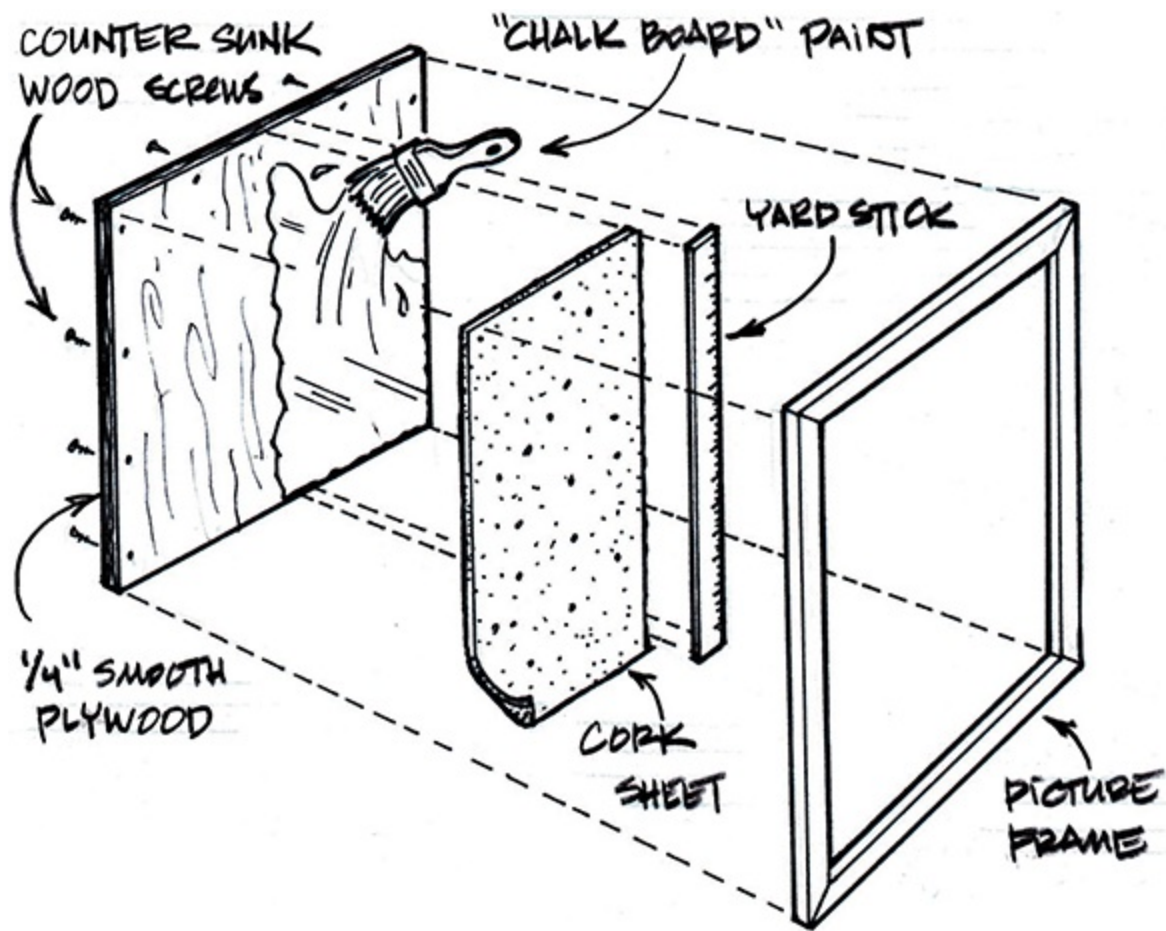
Stack until you have them all stored! For more useful Lego organization tricks check out evilmadscientist.com/go/efficientlego

★ CONSIDER A HEAT-SEAL ORGANIZER

One method you can use for mid- or long-term storage of parts, materials, equipment, and supplies is to bag and heat-seal them. You can get used heat-sealers on eBay for around US\$50. It's super easy to bag and tag all sorts of shop clutter, and the bags protect the contents from bumps, scratches, and corrosion. Several different-sized rolls of plastic will accommodate many shapes and sizes of objects you wish to bag, tag, and store.

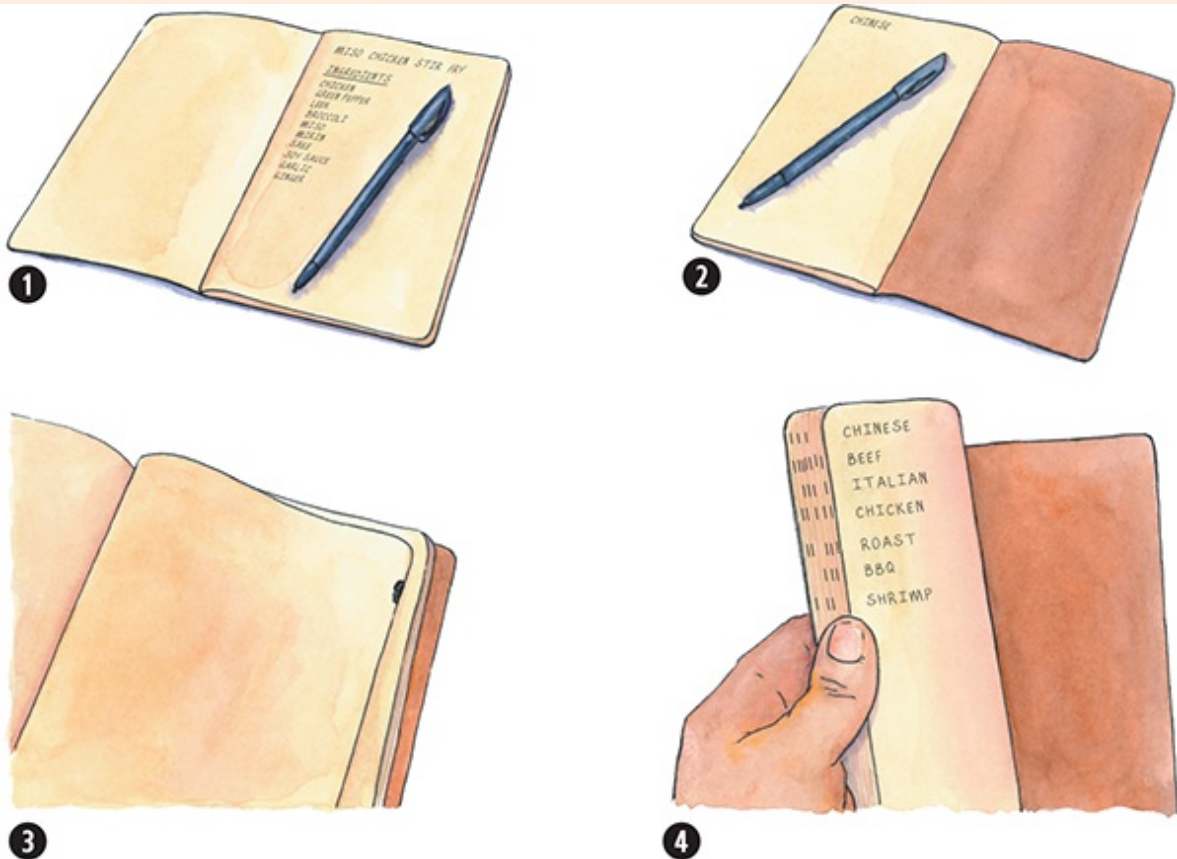
★ MAKE A SIMPLE BULLETIN/CHALKBOARD

For complete instructions, search for "Make a Combination Blackboard/Bulletin Board" on makezine.com.



NOTEBOOK KEYWORD INDEX

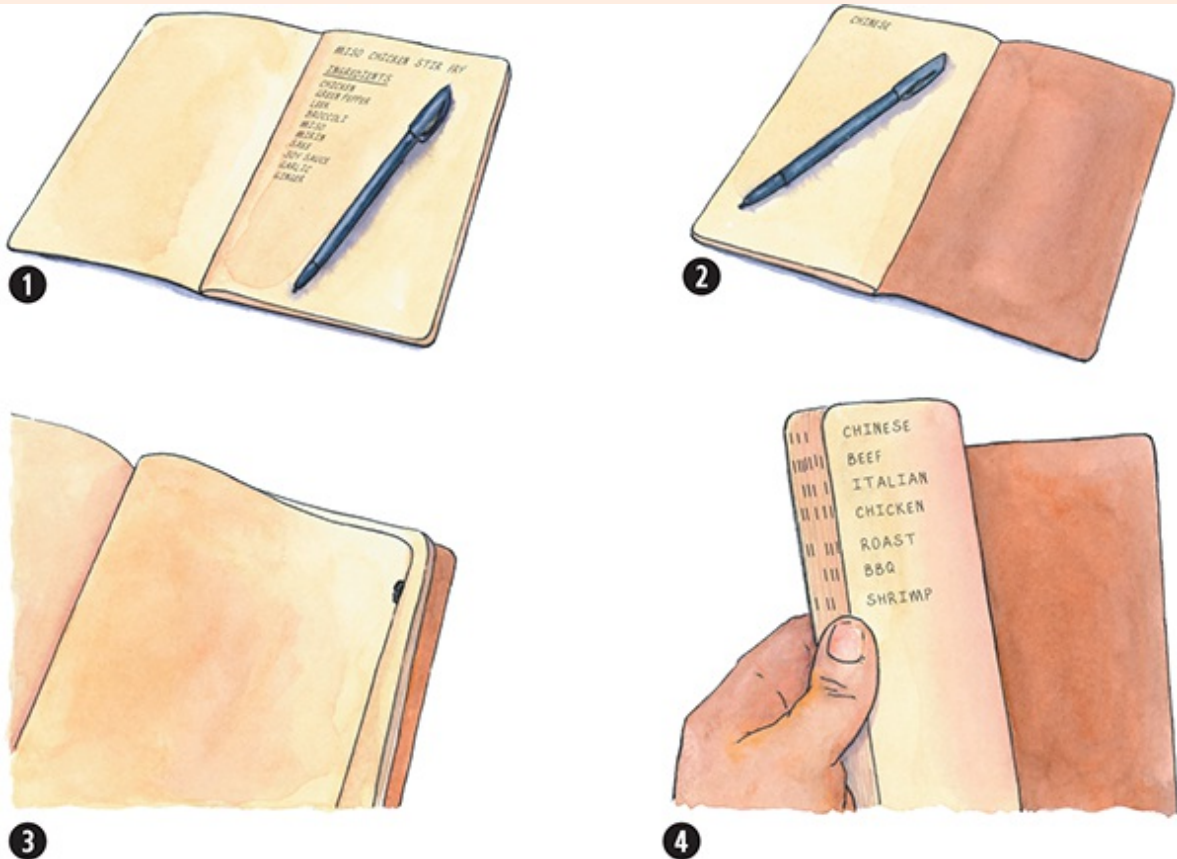
I was so thrilled when I ran across this notebook hack, allegedly from Japan, on Instagram. I fill up lots of notebooks and frequently use a single journal for work ideas, personal projects, and domestic planning (trips, meals, shopping, and so on). Finding things in makers' notebooks across volumes, and within volumes, can be a real chore. The only real way of fixing this access problem is taking the considerable time to index everything.



This simple approach allows you to fairly quickly build a back-of-book index of significant content as you go (you could build it in the front of the book, too). Here's how it works:

1. First you start off with your content. In this example, Adam, who runs the blog "High Five", is making a recipe book. Here's his first recipe.

2. He creates a listing of recipe types on the final page of his recipe notebook.
3. Based on his index of recipe types, he puts the appropriate marking on the outside edge of the page for this Chinese recipe.
4. Next, you can see that by placing corresponding marks on the edges of the pages that map to the recipe index in the back, Adam has organized his recipes for much easier access.



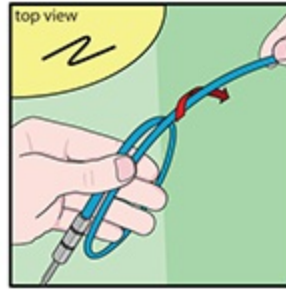
I'm definitely going to start doing this in all of my notebooks. [\[VIA ADAM/HIGHFIVE BLOG\]](#)

Tricks of the Trade

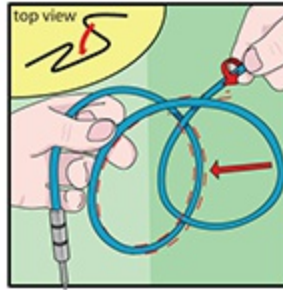
Tim Lillis (narwhalcreative.com)



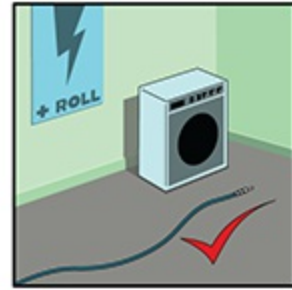
Tangled cables? Try this trick, shared by legendary axe man Adam Carson, to keep your cables neat and ready to spring out tangle-free.



Begin with one end in your hand, facing toward you. Start wrapping the cable in a clockwise motion, twisting it about 180° away from you as you complete the loop.



As you make the next loop, twist the cable again, this time 180° toward you. Tuck that loop in between the 2 parts of the first loop, and continue alternating the 2 steps until the cable is coiled.



When it's time to use the cable, simply hold one end and toss the other. Watch your cable uncoil gracefully and without tangles.

★ MAKE YOUR OWN POCKET NOTEBOOKS

I've been using Moleskine Cahiers pocket notebooks every day since 2006. I have dozens of volumes of them filled with article ideas, design sketches, notes on my day, and various other scribbles. They're fun to go back through to see where my mind has been over the years. I often find buried gems I can use today. As much as I love Cahiers, they aren't cheap. And while I customize mine with cover art, stamps, and stickers, it's just not the same as if I'd made them myself.

Bob Clagett of "I Like to Make Stuff" makes his own (see his "Pocket Notebooks" how-to on YouTube). When you make them yourself, you have something that's infinitely customizable using your preference of cover paper stock and design, internal paper (or combination of paper types), pockets, size, and so on. I've made a few of my own over the years and they definitely hold a special "inspired object" status in my collection. [BC]

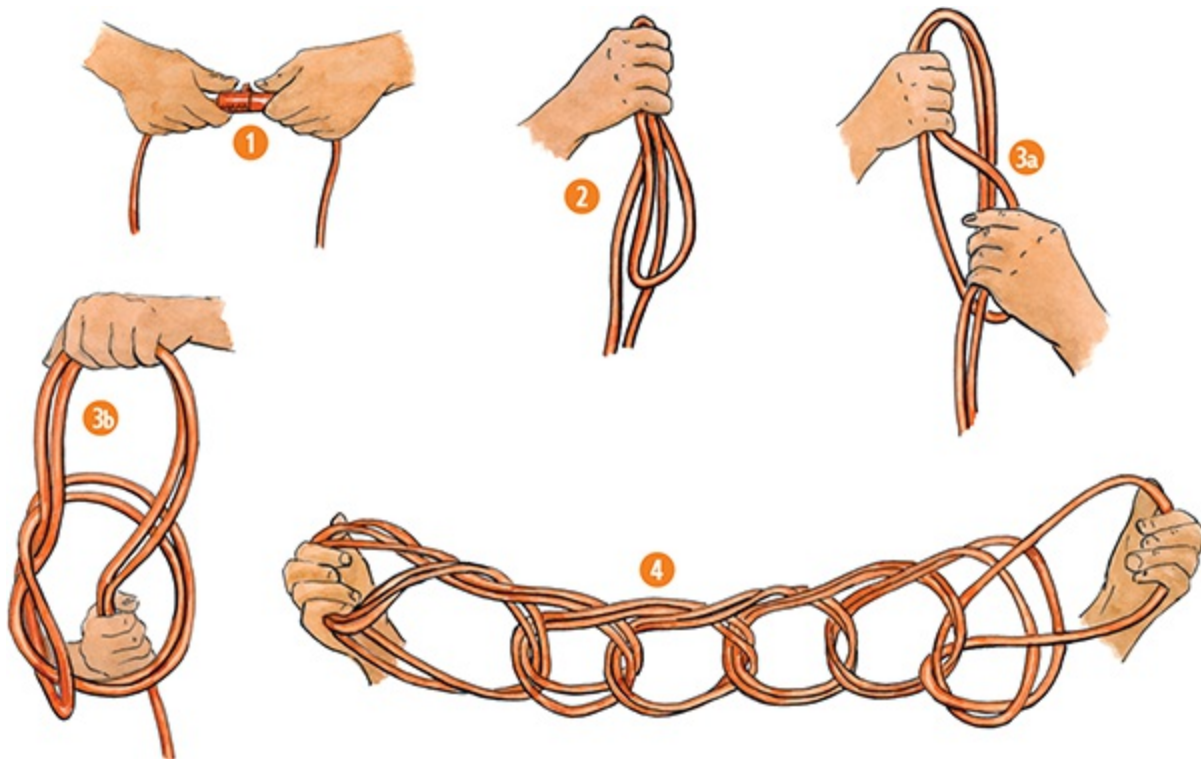
👉 MANAGING YOUR CORDS

On his YouTube channel, homesteader Dirt Farmer Jay offers a tip for a superior, less kinky way to store your heavy-duty

power cords. Starting from one end, work all of the twists out of the cord. The basic steps are:

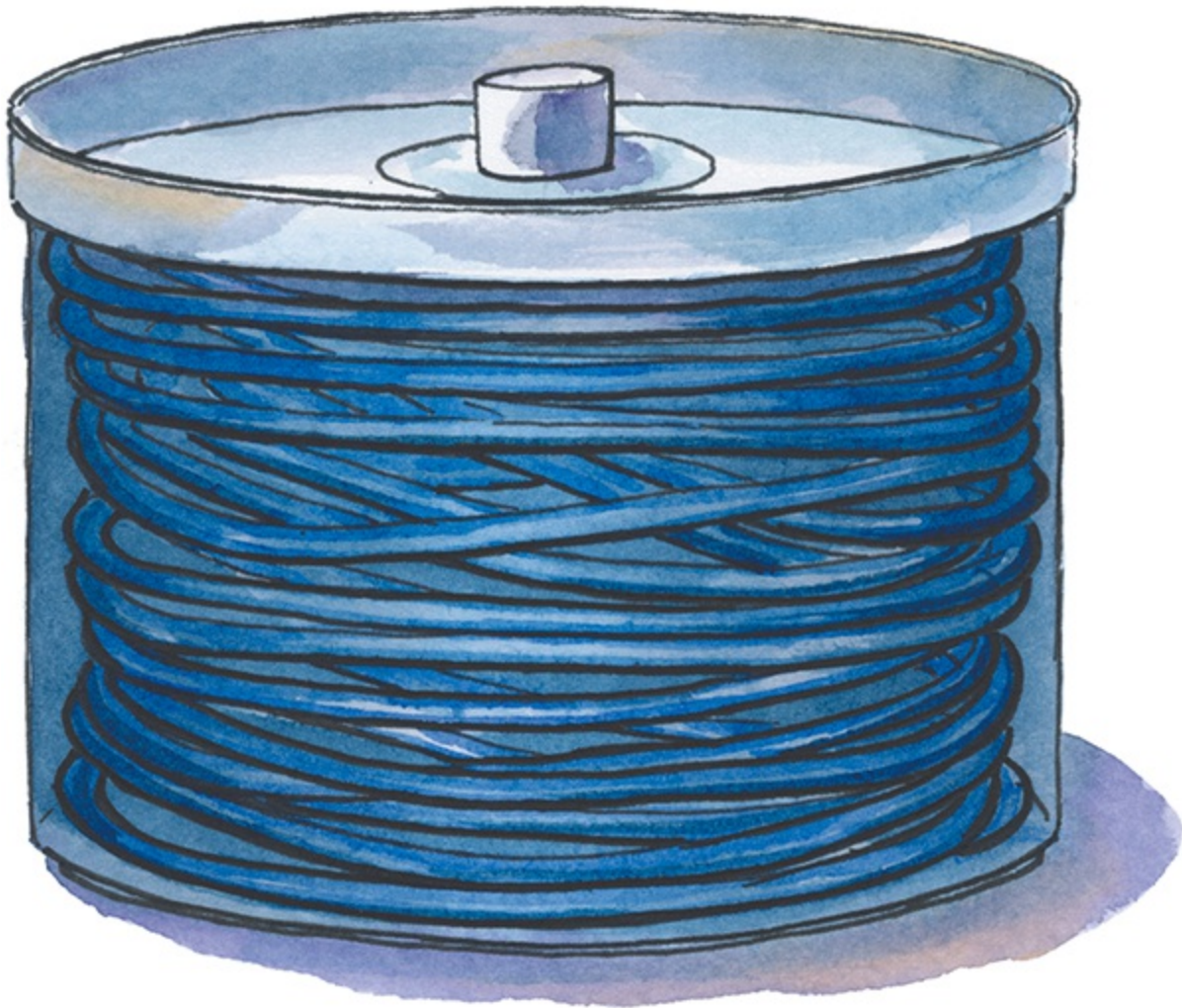
1. Plug the male end into the female end.
2. Grab the doubled cord below the loop that marks the halfway point and flip it over so the loop is facing down.
3. Push the doubled cord through the loop and grab it with your other hand.
4. Repeat to form a chain.

[DIRT FARMER JAY]



★ ORGANIZING CABLES IN CD SPINDLES

If you have empty CD/DVD spindles lying around, they make decent cable organizers.



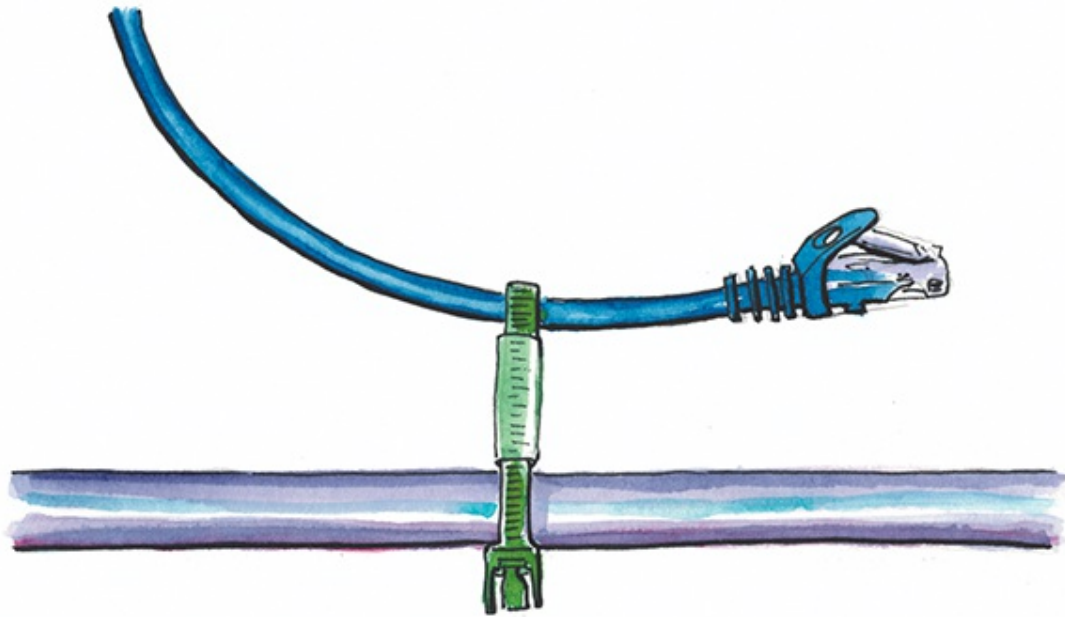
STANDING-OFF CABLES USING ZIP TIES

This trick is from Donald Bell of Maker Project Lab: “This is an easy, useful way to stand-off cables across a length of conduit using zip ties and cheap vinyl tubing. It’s a way to tidy up electrical wiring, fuel lines, data cables, pneumatic tubes, and bicycle brake lines.”

1. Cut off a $\frac{3}{4}$ " section of clear vinyl tubing. You can get this stuff cheap as aquarium air pump tubing.
2. Run your zip tie through the small section of tube, leaving it sitting midway down the zip tie like a ring.
3. Take the pointy end of the zip tie and wrap the smooth

side around whatever you're trying to wrangle.

4. Shoot the pointy end back through the ring of vinyl tubing. You should now have a looped cable on one side of the tube. On the other side, you should have the two ends of your zip tie with the smooth sides facing each other.
5. Cinch up the loop by adjusting the vinyl tubing ring toward the cable, creating enough length for the ends of your zip tie to be secured around whatever you're fastening it to.
6. Zip it up, trim off the extra, and repeat as needed. **[DB]**



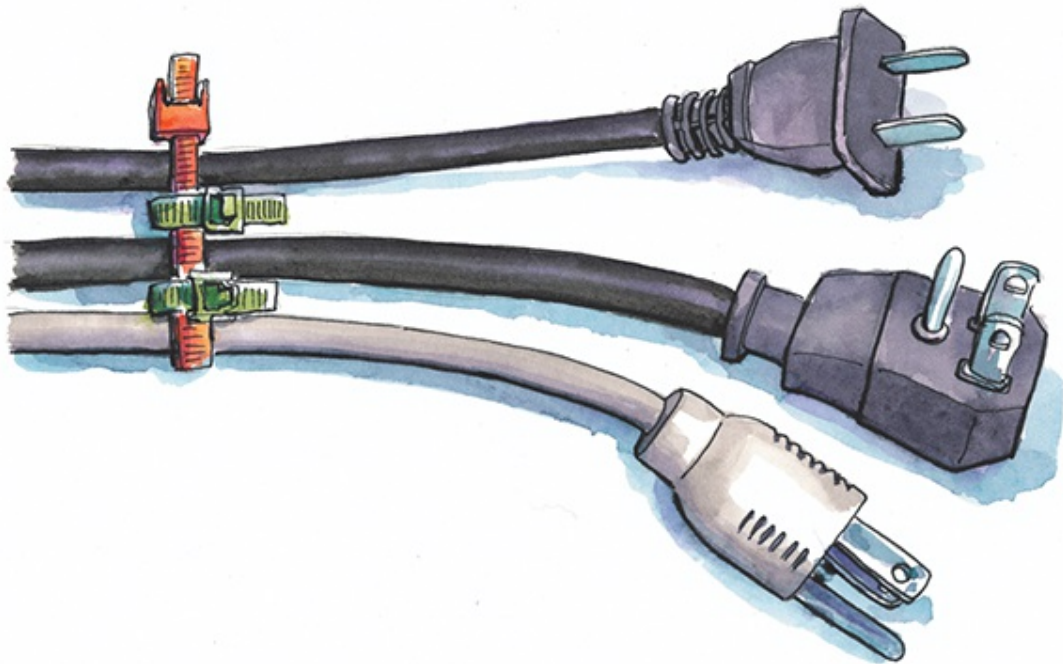
CABLE WEAVING WITH ZIP TIES

Also from Donald Bell: "I came across this tip as a way to harness spark plug cables in your engine. It's a great way to gather up any group of thick cables, while simultaneously keeping them separate from one another."

1. Lay your cables down parallel to one another and count them. The number of zip ties you'll need is equal to the

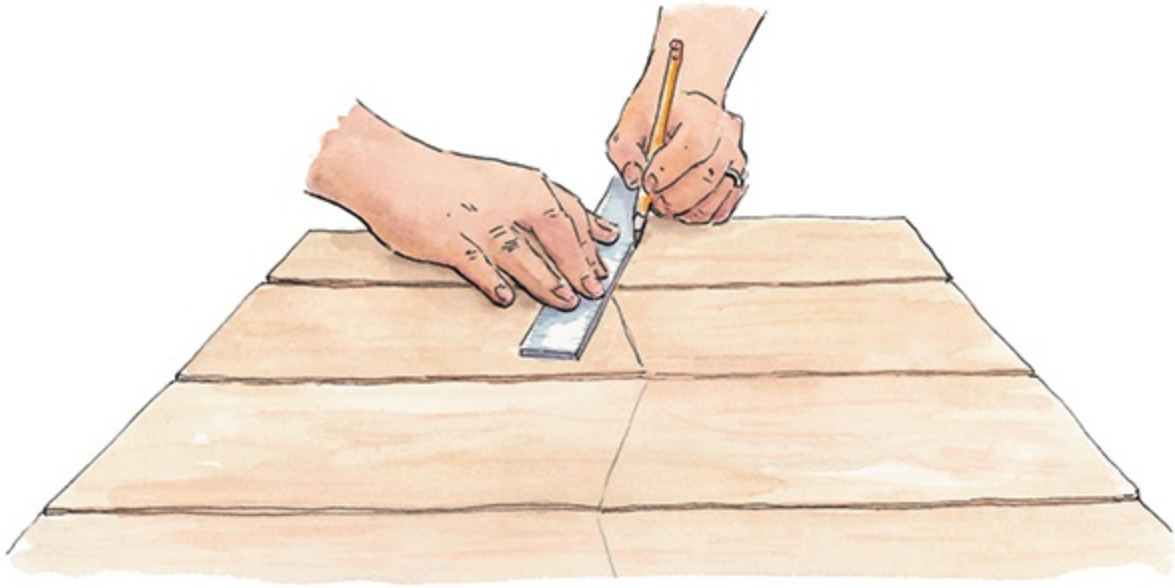
number of cables.

2. Loosely attach one zip tie across the entire bunch of cables like a collar, leaving plenty of slack.
3. Tie loose, perpendicular rings completely around the first zip tie between each cable, parallel to the cables.
4. Tighten the first zip tie, and then move on to the small rings. Now, trim the excess. **[DB]**



★ **ANGLING BINS**

In one of Bob Clagett's I Like to Make Stuff videos, he makes a sweet little spinning shop organizer. One of the things he did that I think is worth pointing out is angling his shelves downward toward the center. This prevents things from rolling out of the cart as it's moved or spun. **[BC]**



★ **CREATING PVC PIPE SPRAY CAN HOLDERS**

On Geoff Meston's Stuff I Made YouTube channel, he shows a really quick, simple, and I think righteous, way of creating holsters for your spray paints and other aerosol products. He simply cuts and mounts a C-shaped length of PVC pipe. The short, C-shaped pieces of pipe are flexible enough to open and hold the cans, and they will easily release the cans when you want to remove them. [GM]

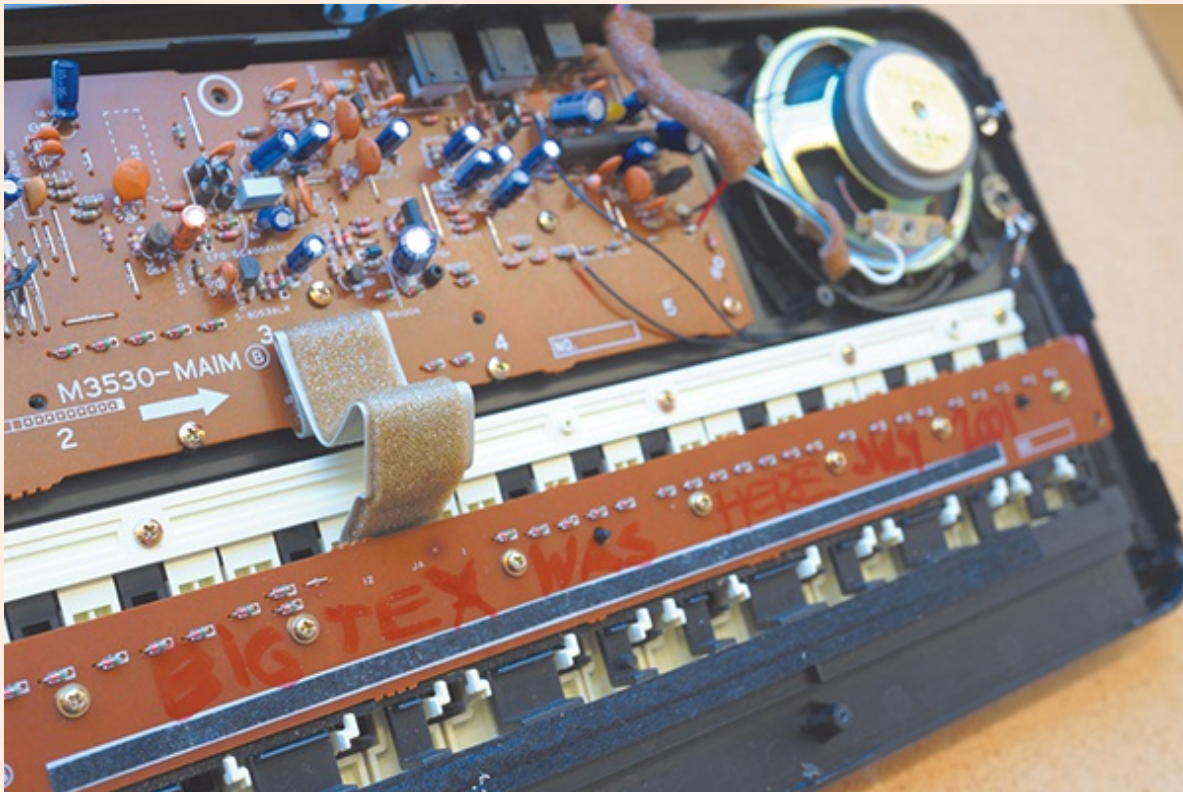
🔧 **BROKEN ON PURPOSE**

When I was 23, I picked up a soldering iron for the first time so that I could deliberately break a Casio Rapman keyboard. As an electronic musician hunting for unusual sounds, I found myself drawn to circuit bending—the art of short-circuiting audio toys to create glitchy, unintended sounds.

After years of stockpiling thrift store electronic toys and keyboards in the hopes of someday modifying them and mining them for audio samples, I found a mentor who could show me how to do it. With a soldering iron and a small toolkit in hand, Tavys Ashcroft (aka Big Tex) came by my apartment

to show me how to poke around circuit boards in search of these weird tones. Once we found one we liked, we'd then wire up these unintended connections to switches so they could be triggered on command. Afterward, we went to a surplus electronics store that immediately felt like a natural extension of my thrift store obsession.

Since I'm an artsy musician with an English degree and an affinity for obnoxious, bizarre things, circuit bending was the best possible way I could have been introduced to electronics. It felt more like remixing and vandalizing than a path to hobby electronics. But somewhere along the way, I became curious about what all those resistors and capacitors were actually supposed to be doing.



I still have the Casio Rapman keyboard that Tavys and I worked on. It's a fun artifact from a day that put me on the path to becoming a maker. It's also a reminder that the right project can compel makers out of their comfort zone and challenge their definition of who they are and what they're capable of.

-DONALD BELL

2

PROJECT PLANNING

Have you ever heard of the “hassle tax?” Years ago, when I was running a graphic design business, I was talking to a friend about an upcoming job that I was dreading because the client was a royal pain to deal with. I questioned whether I should even take the job; it wasn’t worth it. “Add a ‘hassle tax,’” he said. A what? He explained that, when dealing with particularly difficult clients, he added a percentage onto their job quote that took into account having to deal with the additional difficulties. “Charge what you need to get to feel OK about working with them. If they go for it, then the extra hassles are paid for,” he said. I instantly added the hassle tax to my job quotes for particularly difficult clients, and my design business lived happily after.

★ **LEARNING WITH THE FEYNMAN TECHNIQUE**

I have a confession to make. Before I wrote my book, *Absolute Beginner’s Guide to Building Robots*, I had actually built few robots. But I was writing about robots for *Wired* and elsewhere, I got asked to do a DIY robot book by a publisher, and I really needed the money. So, I said yes. I would study heavily, do a lot of trial-and-error building, come up with something that worked, and then write about it. I ended up with a book that one newspaper said set “a literary standard for how tech books should be written.” It became a book that was used in high school and college tech courses and that inspired many a high school science fair project. A UK professor was using it in his class and wrote begging me to

write a companion guide to AI.

I didn't know it at the time, but I was basically applying the learning technique used by celebrated American theoretical physicist Richard Feynman. Basically, the idea is that, as you learn something, you mock-teach it back to yourself by explaining it in writing and out loud, as if you were teaching a class. By doing this, you not only improve your retention of the material by reinforcing the concepts, you find the holes and weaknesses in your understanding so you can go back and study those parts again. I think this is also what made my book work so well. My understanding was fresh; I had a beginner's mind. Because experts know their subjects so well, they often make a lot of assumptions about what people already know, or fail to identify basic things that need to be covered. For a newbie recording his or her journey of discovery, all of those things are fresh and still visible.

🔧 **DUE DILIGENCE (AND ASKING MOM TO FIX IT)**

My dad is not really a maker, but he did inspire me to work very hard at whatever task I set my mind to, and for that, I'm grateful. Teaching someone a good work ethic, teamwork skills, and diligence are just as valuable as showing someone how to use a drill press or a soldering iron. Oh, and he also taught me that mom was probably the better person to go to when things got broken. 😊

-LIBBY BULLOFF

★ **“PRE-MAKING” MISTAKES IS A GOOD IDEA**

Well-known YouTube maker Andy Birkey does a lot of historical architectural restoration, without a lot of room for error. He can't afford to fail, scrap the piece, and try again. So, what he does before and during a project is try to anticipate (and work to avoid) every possible thing that could go wrong. He calls this

pre-making mistakes. He says that taking the time to inventory everything that you might do to mess something up, and adjusting yourself accordingly, should at least prevent you from making the stupidest of those mistakes. I think this approach is useful in any sort of making. I have always thought that one of the things that separates the reckless amateur from the safe and seasoned maker is the ability to innately understand, anticipate, and react to all of the physical forces, tools, and materials one is working with. When you are beginning, it helps to do this intentionally. For a pro artisan a lot of the “pre-making mistakes” processing is going on subconsciously all of the time. **[AB]**

★ **IMPLEMENTING THE KENNY ROGERS RULE**

This is one of my “Rules for Roboticists,” taken from my 2004 book, *Absolute Beginner’s Guide to Building Robots: When you’re building anything, especially something as complicated as a robot, the build can sometimes get ugly. If you try to force your way through, you can often dig yourself into an even deeper hole. So here’s what you do: Put the soldering iron down. Step away from the steaming robot entrails! You’ll be amazed at what taking an hour away, vegging in front of the TV, rolling around on the floor with the cat, or sleeping on your problem will do. It almost never fails. Here’s a corollary: The extent to which you don’t want to drop what you’re doing and take a break (“I know I can fix this, damn it!”) is inversely proportional to the extent to which you need to take that break. Why is it the Kenny Rogers Rule? ‘Cause as Kenny “the Gambler” Rogers wisely tells us:*

You’ve got to know when to hold ‘em, know when to fold ‘em
Know when to walk away and know when to run

 **THE UNIVERSE IS A COLLECTION OF PARTS**

While working at Make:, I met an inventor named Perry Kaye. He had a brilliant approach to prototyping his designs. He didn't try to reinvent the wheel he just used existing wheels from something else! He called this approach "Frankenstein prototyping." When Perry came up with a possible new invention, rather than going the conventional route of drawing up plans, then paying a rapid prototyping service or someone else to fabricate it, he'd just head to Home Depot, Toys "R" Us, and the local hardware store. He'd find the parts he needed on existing products (a handle here, a type of blade there, this motor, that gearbox). Then, he'd cut up these existing products, remove the parts he needed, and cobble them together into his new monster creation.

This is an incredibly powerful perceptual shift—to see the physical world around you as a collection of parts that are currently in one configuration, but are just waiting to be taken apart and recombined into something new. Especially with today's 3D printers, high-performance adhesives, and silicone rubber modeling clays like Sugru, "recombinism" has never been easier.

Besides saving time and money, Perry thinks there's an added benefit. When you've spent so much on a prototyped idea, you become literally invested in making that design work, even if it doesn't. You're reluctant to abandon it because you don't want to have to go back to the drawing board. But when you've only invested an afternoon and a few bucks on a Frankenstein prototype, you're more likely to just salvage whichever parts you can, and move on to the next idea. So, this method of rendering your ideas allows you to iterate quickly and gets you to a smarter, more viable design that much faster.

Of course, you don't need to be an inventor in the classic sense to benefit from this way of looking at the world. You can make one-off creations with this method, or solve vexing design deficiencies on existing projects. We have this perceptual blindness where we tend to see things as they are rather than the potential for what they could become. Frankenstein prototyping is a way of training oneself to look for that potential.

—GARETH BRANWYN

★ **TAKING IT BIRD BY BIRD**

I couldn't write this book without sharing one of the greatest tips I have ever taken to heart. It is a work approach that has truly saved me from my attention-deficit and procrastination failings. It comes from American novelist, essayist, and writing teacher Anne Lamott. In her book on writing and life, *Bird by Bird*, she tells a childhood story about her family being away at their cabin all summer. Her older brother had been assigned a school report on birds that he had put off even starting all summer long. Now, the night before returning home (and to school), he sat at the cabin's kitchen table, paralyzed at the sight of a pile of bird books and a stack of 3×5 cards. His dad sympathetically patted him on the shoulder and said: "Bird by bird, buddy. Just take it bird by bird." Lamott was a classic procrastinator, and that idea stuck with her. To overcome any procrastination when she needs to write, she tells herself she needs to at least produce the equivalent of one 3×5 card, one bird, of work. Of course, what happens is she sits down and ends up creating two birds, or three birds, or a dozen. I use this technique every single day. If I collaborate with other busy people, and know that finding time to work on our mutual project will be difficult, we make sure to advance those projects bird by bird. I also use the bird-by-bird self-trickery for my daily miniature figure painting (my hobby). Often, it's hard to peel my eyeballs off of the computer or phone screen long enough to sit down for a painting session. Telling myself I only have to accomplish a bird, a single task, is enough to break the surface tension that motivates me to start painting. Once in the seat, I rarely leave before an hour has passed. So, when you get overwhelmed and paralyzed by the prospect of tackling a task, pat yourself patronizingly on the back, grab that stack of 3×5s, and just take it bird by bird.

★ **FINDING POWER IN THE NAMES OF THINGS**

Being a word nerd, I've always been fascinated by slang, jargon, and technical terms—the wild west of language. I have applied this same interest as a maker. I pay attention to the proper terminology for different technologies, disciplines, materials, and processes. I've come to realize that there's an incredible advantage in learning and communicating about a discipline if you know its language. In magical beliefs, knowing the true name of a thing or people gives you power over them. I think there's some real truth to that. Knowing what things are called can greatly accelerate the learning process. Search engines are fairly forgiving these days in terms of allowing you to describe things if you don't know the proper name, but it's still a good idea to try to identify, retain, and use the proper terminology.

★ **BUILD EARLY; BUILD OFTEN**

I've always loved the writer's adage "Writers write." Writing is like a muscle that you have to use regularly to improve and strengthen it. The same goes with any building activity. Makers make. If you're regularly using your tools, and trying out new projects, new techniques, new tools, you will get better, and you will master your shopcraft. In *Make: Volume 50*, Jimmy DiResta shared a related tip: "If you want to learn how to use a new machine, start making something on it immediately! Among other things, you quickly learn how to hide your mistakes."

★ **GETTING OUT OF THE HELSINKI BUS STATION**

Have you ever heard of the Helsinki bus station theory of creativity? Well, as the story goes, there is one major road leading in and out of the main bus station in Helsinki, Finland. Regardless of what bus you get on, for the first few miles they

all travel down the same route and make the same stops. The theory likens this to starting a new creative endeavor or a new artistic career. For a while, regardless of how hard you try, your work is likely going to be derivative and not very inspired; same route, same stops. People will liken your work to others, which might discourage you. But, like the route out of Helsinki, if you stay on the bus (if you do the hard work, learn from your failures, and perfect your craft), eventually all of the buses will veer off in their own unique directions. To find out more, do a web search for “Helsinki bus station theory.”

DAD TEACHES SOUND PLANNING

When I was very young, maybe six or seven, I told my grandfather that I wanted to dig a swimming pool or a fishing pond in his backyard, complete with an underground room with a window to watch the fish (I may not have all of the details right, but it was something like that). Instead of saying, “Sure, go ahead” (dismissively) or “That’s crazy,” he said, “That sounds expensive and you need to have a good plan before you get started.” He sat down with me and made me draw up my idea, identify the materials and tools, estimate the costs, and figure out how long it would take. He even added up all of the costs on his big adding machine and stapled it to my drawings. He then said I could refine the plans and start saving my money and get started as soon as I could handle it. It sounds like he was just saying “That’s crazy” or “Yeah, right” the long way around, but he taught me to draw plans, make lists, and evaluate cheaper alternatives (“Maybe you could add the underwater viewing area later?”). He also took me seriously and encouraged me to combine my creativity with basic engineering facts.

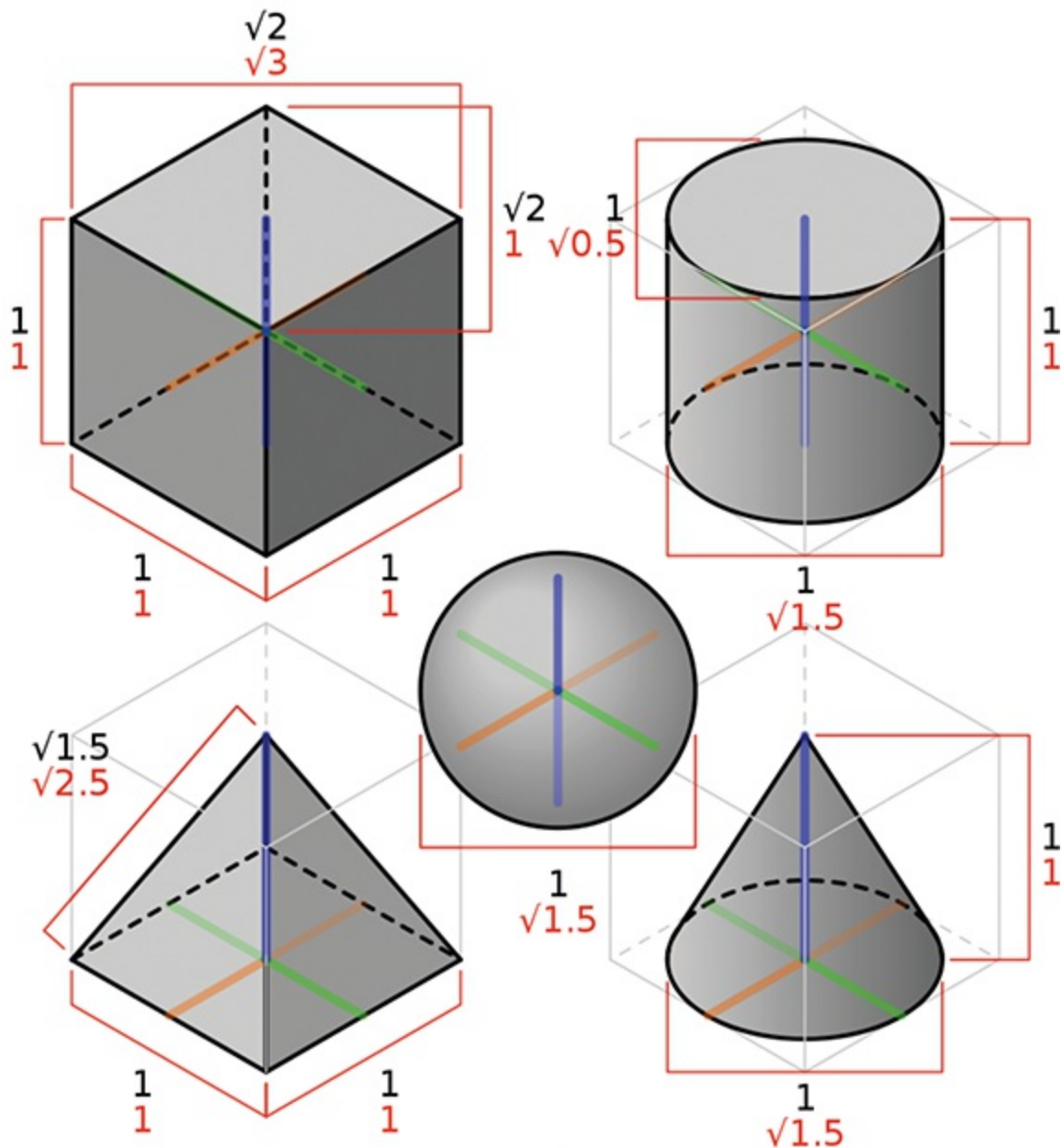
—CHRIS PALMER

★ **LEARN TO DRAW ISOMETRICALLY**

Learn to draw in isometric perspective; it can really help you

better visualize a project. Isometric drawing—drawing 3D objects in 2D space—is a great way of rendering objects so that you can better understand how they go together. You can get notebooks and pads of paper that have isometric gridlines on them to make drawing in 3D easier. [\[HITD\]](#)

Draw Isomorphically



Learn to draw in isometric perspective, it can really help you visualize a project.

★ **ORDER MORE THAN YOU NEED**

Always order 10 percent more materials than you need for a project. And if you're ordering cheap parts and supplies, always order a few extra. [TS]

★ **BUY EXTRA PARTS FOR A VERY IMPORTANT REASON: BEER!**

My friend Tim Slagle shared this tip with me years ago: "Having some extra parts on hand is a great way to help out your fellow hardware hackers. It can also add a social element to what can otherwise be a rather solitary hobby:

"Hey, I need a part for my project."

"I have extras!"

"Awesome; I'll come pick them up . . . and bring beer!"

Over the years, I have frequently shared the tip of always buying extras whenever you buy parts for a project. Having them in stock to share with others is a great way of being generous and social. [TS]

★ **QUOTE ON TWICE THE TIME**

Always quote at least twice the time you think it will actually take to complete a project.

★ **FACTOR CLEANUP INTO JOB ESTIMATES**

"My dad always says that when you are planning a project, make sure you include time to cleanup." [TH]

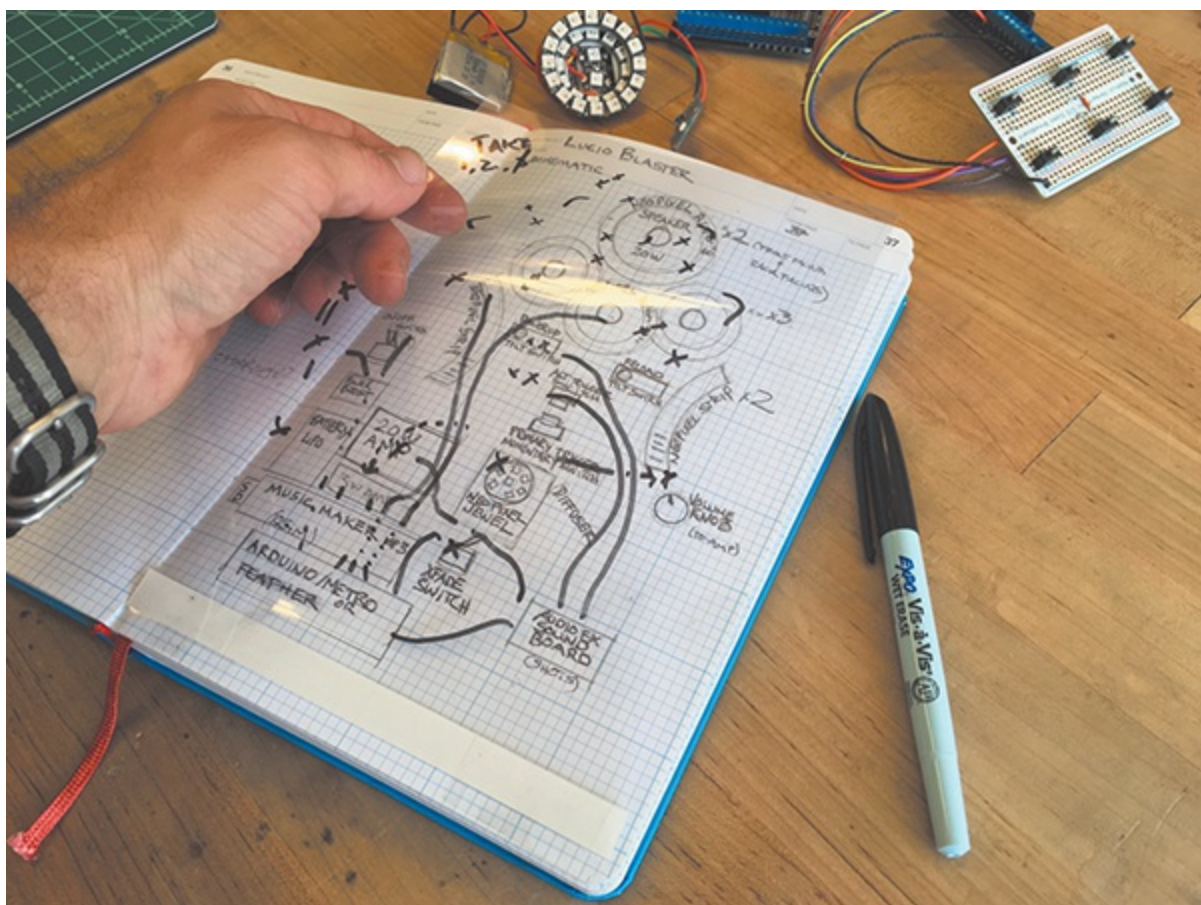
★ **PICK TWO**

You may pick two of the following three—but only two.

- It can be built well.
- It can be built quickly.
- It can be built cheaply.

★ USE ACETATE OVERLAYS IN YOUR NOTEBOOK

When figuring out project wiring or other parts of a project design that might be subject to change, tape sheets of acetate over your design and mark on that with a dry erase marker. That way, you can continue to change things around until you are confident you have the arrangement you need or want. [JEP]



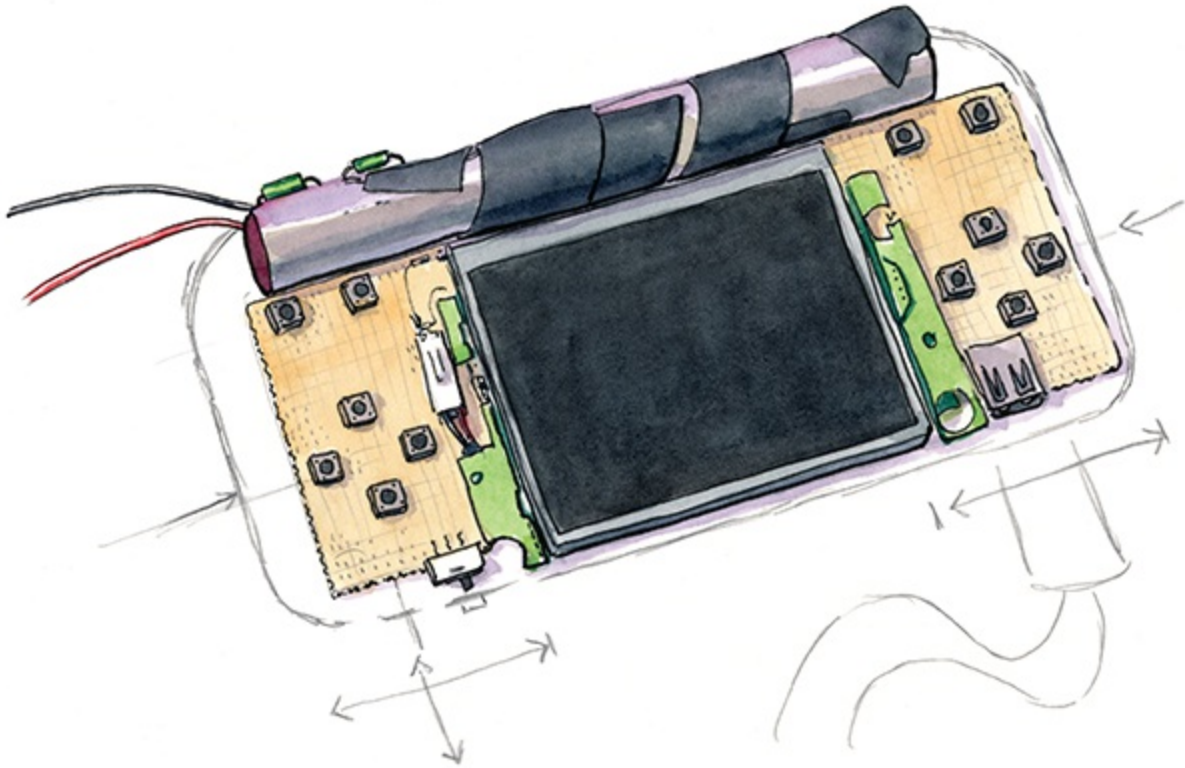
🔧 **NOTHING MORE EXPENSIVE THAN CHEAP TOOLS**

My grandfather was both a professional meat cutter and a spectacular wood carver. When I was a child, he and I would spend hours in his workshop talking about his rather large collection of tools. I remember him saying to me on a number of occasions, "Son, there is nothing more expensive than a cheap tool."

—DAVID STEVENS

★ **LAY YOUR PROJECTS OUT ON PAPER FIRST**

On The Ben Heck Show, in an episode on design tips for electronics projects, Ben suggests that you first draw your enclosure on paper, ideally blocking out the components that will go inside of it. When you're building a workable enclosure, you need to consider all sorts of variables, such as component placement and needed allowances for screws, stand-offs, wire runs, and so on. Physically placing components onto a piece of paper can help you clearly visualize and think through all of that. Once you've worked out all of the placement and measurements, you can transfer your design to a 3D design program. **[BH]**



🔧 THE MAKER'S CHECKLIST

Here are some words of wisdom to bear in mind when designing and executing a project.

- K.I.S.S. = Keep It Simple, Silly. The ideal design has zero parts.
- Work expands so as to fill the time available for its completion (Parkinson's Law). Don't give yourself too much time for a project or it will never get done.
- Past experience is good for a reality check. But too much reality can doom an otherwise worthwhile project.
- Look at how everyone else is tackling a problem—what assumptions are so implicit that they're no longer being questioned. Question them. Don't listen when people tell you that you can't. Ignore your critics.
- Document everything (in writing, and with pics and video), especially on collaborative projects. The group will forget who did

what and it will make going back and changing things that much harder. Also, good docs will make it that much easier to port into makeprojects.com.

- You may pick two of the following three, but not more:
 - It can be built well;
 - It can be built quickly;
 - It can be built cheaply.
- Do what you can, where you are, with what you have (Roosevelt's Law of Task Planning).
- Everything is a spring (i.e., in mechanical system, all parts will deform under load).
- If it moves and it shouldn't, use duct tape (or zip ties). If it doesn't move and it should, use WD-40.
- Design for disassembly. Don't expect it to work the first time you put it together. And make sure that everywhere there's a screw, there's a place for a screwdriver. And a hand to fit around that driver.
- Neatness counts. Keep everything organized and tidy. Use quick connectors when you can, use cable ties to bundle related wires together, color-code, and label.
- Know when to walk away. When a design problem or a build turns ugly, take a break. Sleep on it. You'll be amazed what distance will do—**AKA THE KENNY ROGERS RULE: "YOU GOT TO KNOW WHEN TO HOLD 'EM, KNOW WHEN TO FOLD 'EM, KNOW WHEN TO WALK AWAY."**
- Always use safety glasses, wear proper attire (<https://makezine.com/2009/10/27/toolbox-maker-sartorial/>), keep first aid at hand (<https://makezine.com/2010/02/24/toolbox-first-aid-kits/>), and use the right tools for the job (<https://makezine.com/2013/01/04/toolbox/>).

Boiled down from "Skill Set: The Beginning (Mechanical) Engineer's Checklist" (<https://makezine.com/2011/03/30/the-beginning-mechanical->

[engineers-checklist/](#)), the “Beginning Engineer’s Checklist” (<https://makezine.com/2009/03/15/the-beginning-engineer/>), Gareth Branwyn’s “Rules for Roboticists” (<https://makezine.com/2010/03/30/rules-for-roboticists-1/>), and discussion on makezine.com.

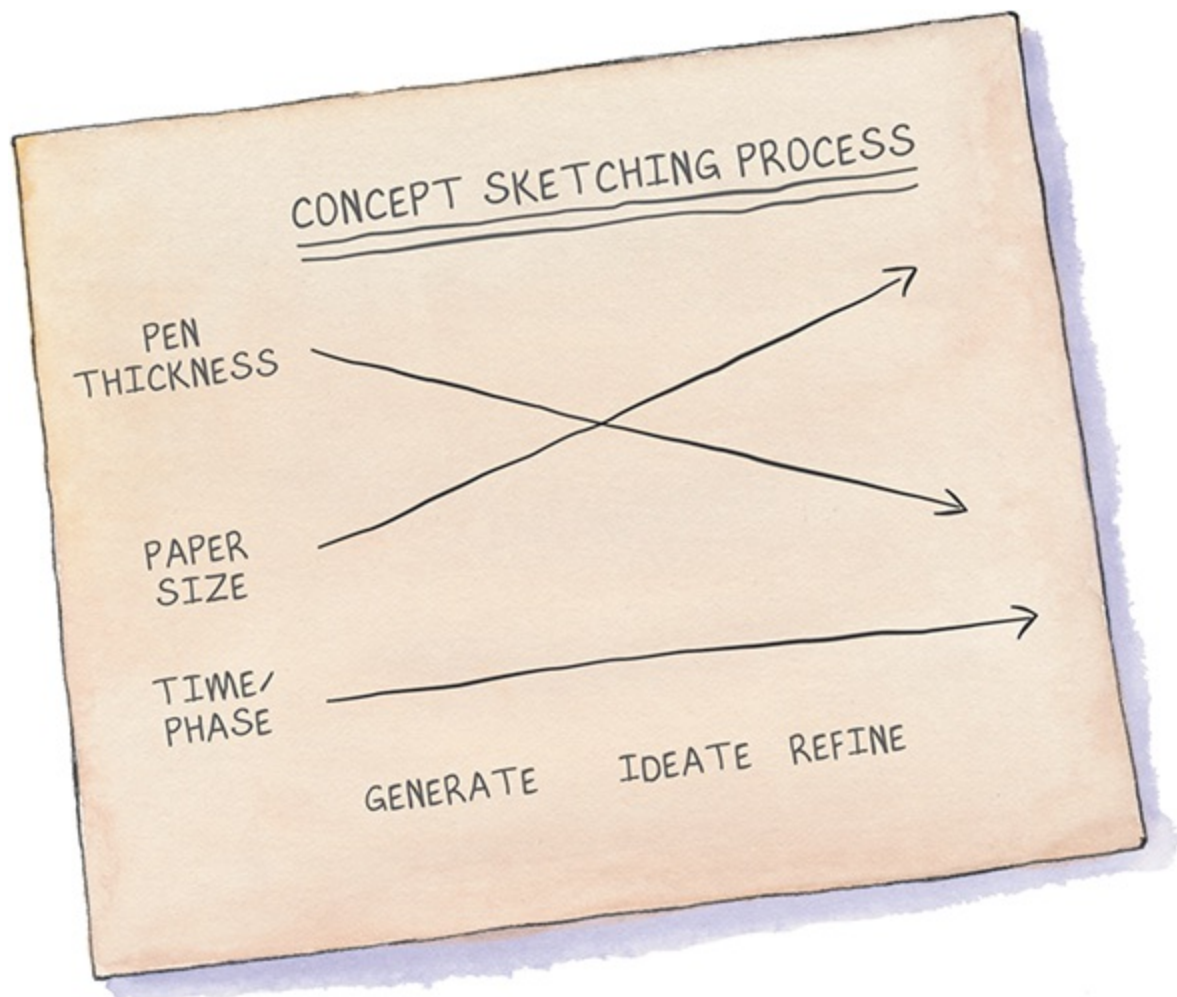
★ **PLAN YOUR PROJECT ENCLOSURE FIRST**

Chris Akiba Wang shared the following tip: “When working on an electronics project, a lot of people jump directly to the printed circuit board (PCB). The first thing I do when approaching a PCB is to think about the enclosure in which the final project will live. If you want your product to look professional when it’s finished, it needs an appropriate enclosure. Choosing an enclosure requires that you think about the end user and how your product will be used. Is it portable? Does it need to be waterproof? Will it be low cost? The enclosure you choose will put boundaries on PCB size and shape. Once you select your enclosure, you can go to town on the board itself.” **[CAW]**

★ **SKETCHING A CONCEPT, THICK TO THIN**

Industrial designer Reid Schlegel offered this tip in a little video shared on his Instagram feed.

Use the thickness of your pens to assist you in conceptual sketching. Use a thick-line pen for broad strokes, and basic and top-level conceptualizing, and then switch to thinner and thinner pens at each stage of refining your design. **[RS]**



MY GRANDDAD: MAKER OF MAGIC

My grandfather was a crazed inventor. All of his life he seemed to be joyously tinkering with his world, hacking the tools and everyday objects around him to improve his life (and to have a few laughs in the process). As a kid, I was in awe of Gramps (as we grandchildren called him). He seemed like a magical being. When he lived in Framingham, Massachusetts, he sometimes played a department store Santa at Christmas. He was Santa Claus to me for the rest of the year.

When he and my grandmother retired to Florida in the late '60s, he converted a Sears metal shed into his backyard workshop. I have these wonderful memories of him flinging open the doors to the shop and standing there, showing off some new device or wacky hack that he'd just dreamed up. Every few weeks, he would go to the local thrift store and buy

whatever junk spoke to him. Hurrying home, he'd be banging around in his shop, with strange sounds and his distinctive laugh (or his equally distinctive Arabic cursing) echoing from within. Finally, he'd emerge, fresh from his latest "Eureka!" moment. One time, he came out of the shop while I was doing some yard work that he'd assigned me. He was grinning ear to ear, and looking more excited than normal. He had on a pair of long pants and a long-sleeved shirt. He turned side to side to show me the setup before he revealed his great new invention. He reached up to the sleeves, undid some snaps, and removed the lower half of each sleeve. He then did the same thing with the pants, unsnapping the legs just above the knees. He stood there, thrilled with his own ingenuity. "Convertible clothing!" he chortled in his deep, Santa-worthy way. It would be years before we'd see this kind of convertible clothing become commercially available, with zippers, and then Velcro, as the sleeve and leg fasteners. Gramps was there first.

Another time, Gramps had gone to the thrift shop and come back with a toaster, a waffle maker, and two electric skillets. He emerged from his mad scientist lab hours later, with his typical flourish of chuckles and satisfied grins. He had turned this box of junk into a pita bread oven.

I wasn't aware of the deep impression my grandfather was making on me at the time, but he ended up, and remains, one of my greatest inspirations as a maker and a creative person. He had this almost predatory eye, which was ever-trained on the world, looking for things to scavenge for parts to realize some idea that had been swimming around in his head for a while.

Those who study creativity know that one of the habits of creative people is to see the world around them as a collection of parts that can be recombined in new, innovative ways. The inventor looks at a pair of skis and a motorcycle, combines them in the mind's eye, and imagines the snowmobile. Thanks to my granddad, I saw this kind of creative "recombinism" in action at a very early age, and have never forgotten it.

—GARETH BRANWYN

★ **LEARNING TO SWIM BY WADING IN OVER YOUR HEAD**

On one of Jimmy DiResta's vlogs on YouTube, he showed off the amazing DuPont power hammer, circa 1890, that he had acquired. Jimmy has been learning forging and smithing and acquired this impressive antique as part of developing that skill set. He said he thought he was in over his head with this machine, but that was a good thing. "This is how I learn. I force myself into situations where I have to commit," says Jimmy.

I, too, have always forced myself beyond my comfort zone in nearly everything I explore. My eyes have always been bigger than my stomach when it comes to learning and what I think I'm capable of. Yes, it can mean that you fail a lot, but you fail faster and you learn a lot in the process. And you always end up much closer to your goal than if you had only tiptoed your way in. When in doubt, dive, dive, dive! **[JD]**

ANTICIPATING NEXT STEPS

My father taught me how to be his assistant on countless home improvement projects. He taught me to observe and to learn. He taught me to anticipate the next steps; to be where he needed me to be before he needed me there, and to have whatever he might need next (e.g., pencil, nail, tool) at the ready. Today, I often work alongside colleagues who are weirded out when they realize that I always have that pencil, nail, or tool in hand well before they realize that's what they need next. They've taught me to hide that pencil, nail, and tool behind my back until they ask for it.

—RICHARD GOULD

★ **BRAINSTORMING AT THE FLEA MARKET**

Anyone who's watched a lot of DiResta project videos and vlogs knows that he's a big fan of flea markets. He does buy a

fair amount at these sales, but one of the main reasons he goes is to stimulate his imagination; to see all of the many ways that engineers have mechanically solved hardware design problems over the decades. “Shop with your eyes, not your wallet,” says DiResta. “When I walk through a flea market, I come up with my best ideas.” He says to always go to the market with a notebook and a pen (or write inspirations on your hand).

SEVEN THINGS TO CONSIDER BEFORE HIRING A MACHINE SHOP

If you're looking to have a machine shop create a part for your project, STOP! Ordering parts from a machine shop can be a complex process, and if you're not careful, you could run into problems. Before you ask a shop to provide a quote and make your part, I have some advice to consider before finalizing your design and placing an order.

Why should you listen to me? I work at eMachineShop, which has been fabricating custom parts since 2003. We use additive processes such as 3D printing, and subtractive processes like computer numerical control (CNC) machining, water jetting, and wire electrical discharge machining (EDM). We have more than 10 years of experience making parts for just about any application you can imagine. We have learned quite a bit about working with novice makers and designers, and have used this knowledge to create an ordering process that minimizes the chance of something going wrong. We also offer a free CAD program where you can design parts, review them for machinability, check the price, and order them right from your computer.

So what do we at eMachineshop count as the seven most important things to check before pulling the trigger on any machine shop order?

1. Specify your tolerances

Specifying tolerances correctly is an incredibly important step toward making sure the part that's being manufactured will work as intended. Tolerance is just a way of specifying a range for a

measurement, so 1.000 ± 0.005 would be the same as saying 0.995 to 1.005. Although a part for an art piece might not require tight tolerances, if your project requires precision and exactness, setting tolerances correctly is immensely important to ensure your parts will function correctly.

Another reason to pay close attention to tolerances is that they have the ability to significantly impact the final cost of production. For example, if you submit a design with general tolerances of ± 0.010 " (ten-thousandths of an inch), such a part might be made cost effectively using a water jet. But, if the tolerances for that same part were set to ± 0.002 " (two-thousandths of an inch) it might need to be CNC milled, which is usually a more expensive process. In other words, a small change to tolerances may lead to a large price change. So use tight tolerances only when necessary.

2. Specify surface roughness

Surface roughness specifies the height of the peaks and valleys of the surface at the microscopic level. To minimize cost, use the highest number you are willing to accept. For example, Ra125 is usually economical for machined parts, but if you want a smoother surface consider Ra63 or even Ra32. To get into a really polished range you may need to go down to Ra16 or less.

3. Choose the right material

Choosing the right material seems like it would be easy enough, but there are a few things that should be considered to help further reduce production cost.

Makers often think ordering steel parts is cheaper than aluminum because steel costs less per pound. But this disregards the variable of machining time. Aluminum alloys are ordinarily between three to four times less dense than steel alloys, meaning aluminum is much easier to machine, resulting in less wear on machine tools.

Of course, there are numerous other metals and plastics, each with their own unique set of properties.

4. Be flexible with your material choice

Another consideration when ordering a custom part is that the particular material requested might not be on hand at the time of your order. If your application allows for flexibility, consider extending it to the shop producing the part to reduce both cost and delivery time. So if aluminum 6061 or aluminum 5052 will do, let the machine shop know!

5. Understand the manufacturing process when designing

If you are new to custom part design, or more familiar with 3D printing, it's important to learn before you design the part about how it will be made. Failing to consider the manufacturing process can significantly increase production costs.

One of the most common examples of this is seen in the design of inside corners of custom enclosures. Although it is possible to create sharp inside corners, it's not practical in conventional machining because a spinning cutting tool creates the corner. If you design your part with a sharp corner, your costs will increase exponentially.

6. Be prepared to pay for one-off parts

After designing your part, it is often a good idea to have one or two prototypes manufactured, especially if your future plans include larger scale production. But keep in mind that although machines can make parts effortlessly, there's quite a bit of labor required to program and set up that machine to work its magic. So even if a CNC mill can cut your part in five minutes, it might take significantly longer to set up. This is why orders for just one part can seem expensive.

The cost to set up a machine to make your part is divided by the number of parts you're making. For example, a part design with a combined material and machining cost of US\$1, and a setup cost of US\$100 will cost US\$101 per part. But if you're making 100 of them, the parts would only cost US\$2 each!

7. Don't assume anything!

With so many variables in play, there's always a chance that things may not go as planned. So make sure you specify everything that you need to specify, and leave no room for interpretation. Murphy's law does not make exceptions for custom part fabrication.

Whatever machine shop you work with, do yourself a favor and review this guide before submitting your design. These seven tips will likely save you time and money!

—NICK WALKER

3

MEASURING

Probably the tip of all tips, the ur-tip, if you will, is “Measure twice; cut once.” Measuring is such an important part of nearly every form of making. Measurement can spell the success (or failure) of most projects. Remember the US\$125 million Mars orbiter that crashed on the red planet because there was some imperial-to-metric measurement mishap? Measuring is critical to project success and it can prove very expensive (and embarrassing) when you get your measurements wrong. Here are some tips that makers have discovered to help keep their projects from a spectacular crash.

★ YOUR HAND RULES!

Know the measurements of certain parts of your body (actual length of your foot, finger, or the span of your hand) for doing rough measurements when you don’t have a ruler handy. [\[JD\]](#)

🏠 MEASURING SKY ANGLES

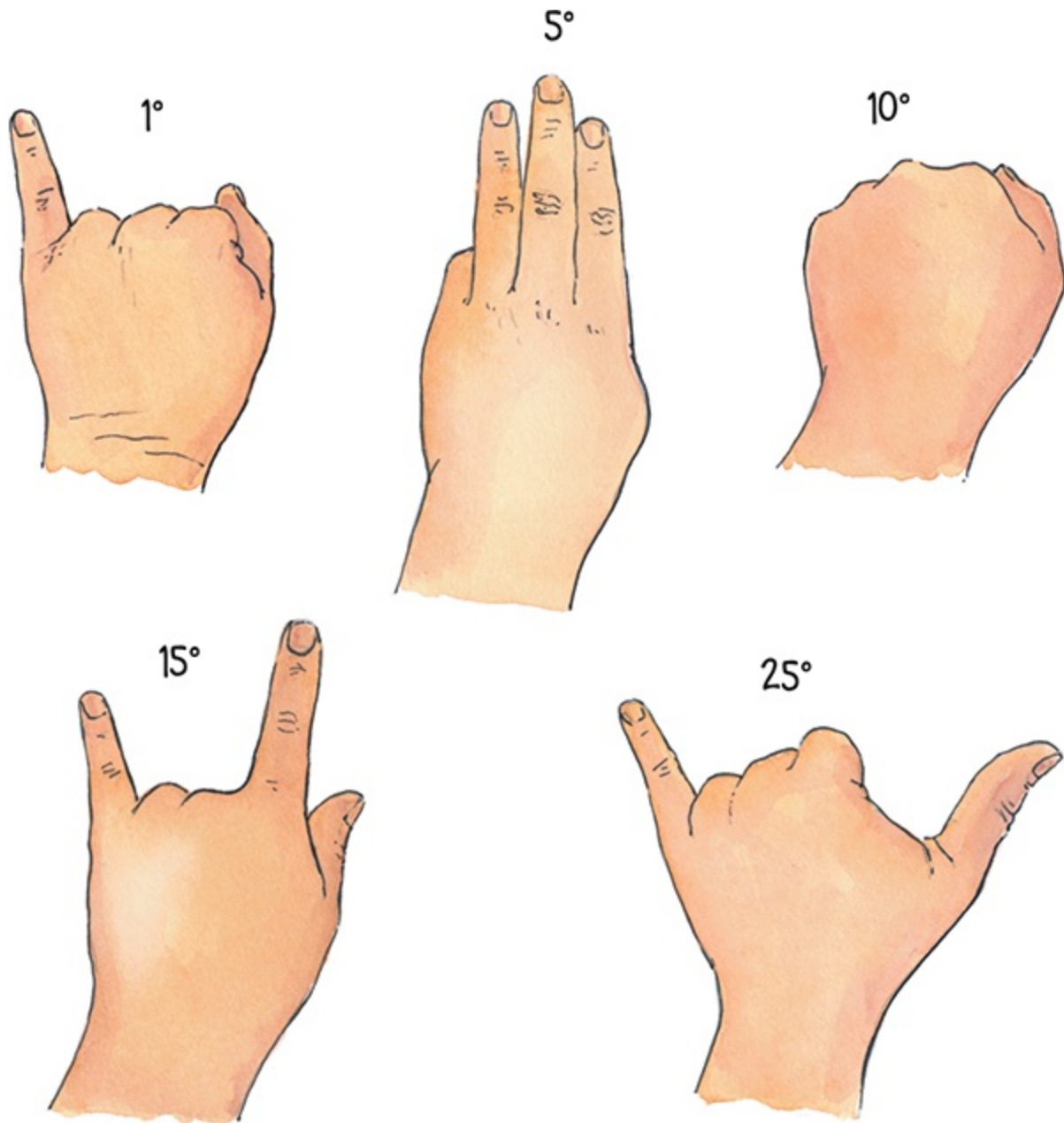
One common trick from the world of astronomy is to use your hands to measure angles in the sky. Here’s how they describe it on One Minute Astronomer:

“... Your hands and fingers are a remarkably accurate (and convenient) measuring tool. When you hold your hand at arm’s length, you can estimate angles like this:

- Stretch your thumb and little finger as far from each

other as you can. The span from tip to tip is about 25 degrees.

- Do the same with your index finger and little finger. The span is 15 degrees.
- Clench your fist at arm's length and hold it with the back of your hand facing you. The width is 10 degrees.
- Hold your three middle fingers together; they span about 5 degrees.
- The width of your little finger at arm's length is 1 degree."

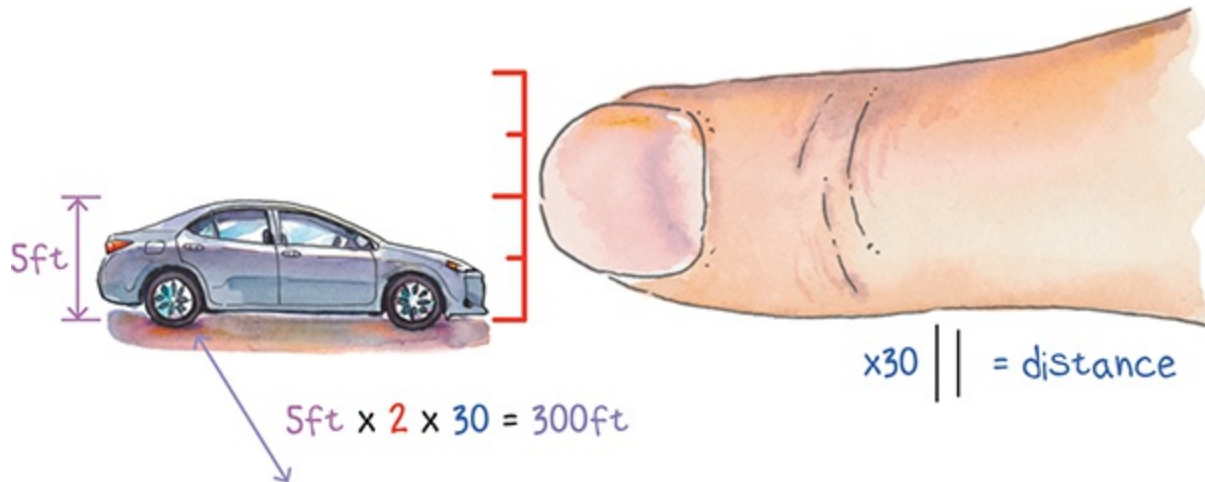


★ MEASURING DISTANCE WITH YOUR THUMB

Here is one more body-part measuring trick: using your thumb to measure distance. This is taken from the old “Your Body Ruler—A User’s Manual,” a document that has been online since the web Jurassic:

“I hold out my arm, look at my thumb, and see a distant car

half as high. Cars are about 5 feet (1.5 meters) high. So my thumb appears 10 feet (3 meters) wide. And since I know my thumb is 30 times as far as it seems tall . . . I know the car is something like 300 feet (90 meters) away!"

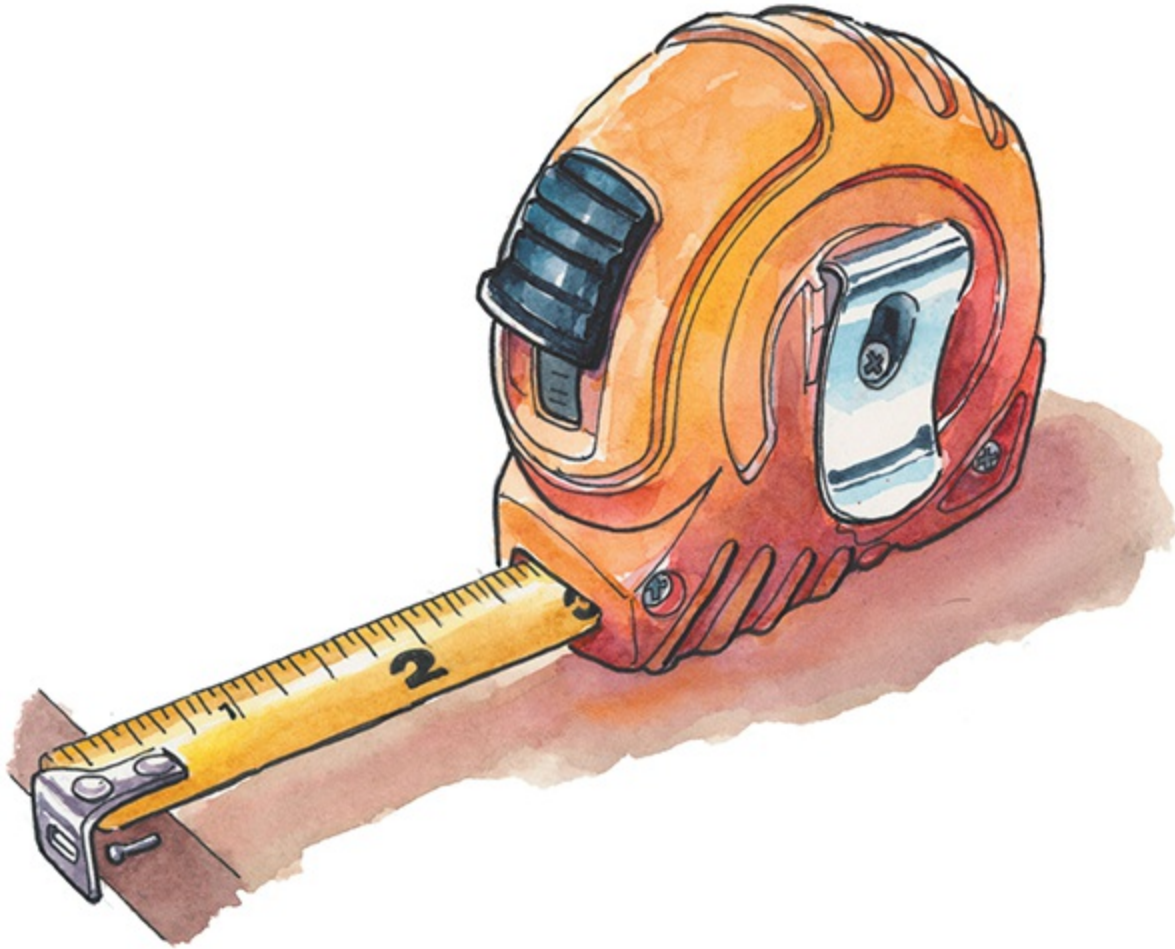


★ A NOTEPAD ON YOUR TAPE MEASURE

Turn one of the faces of your measuring tape into a notepad. Simply sand off the shine on one side of the tape measure's plastic casing and you have a writable and erasable surface to jot down measurements or other information. [CS]

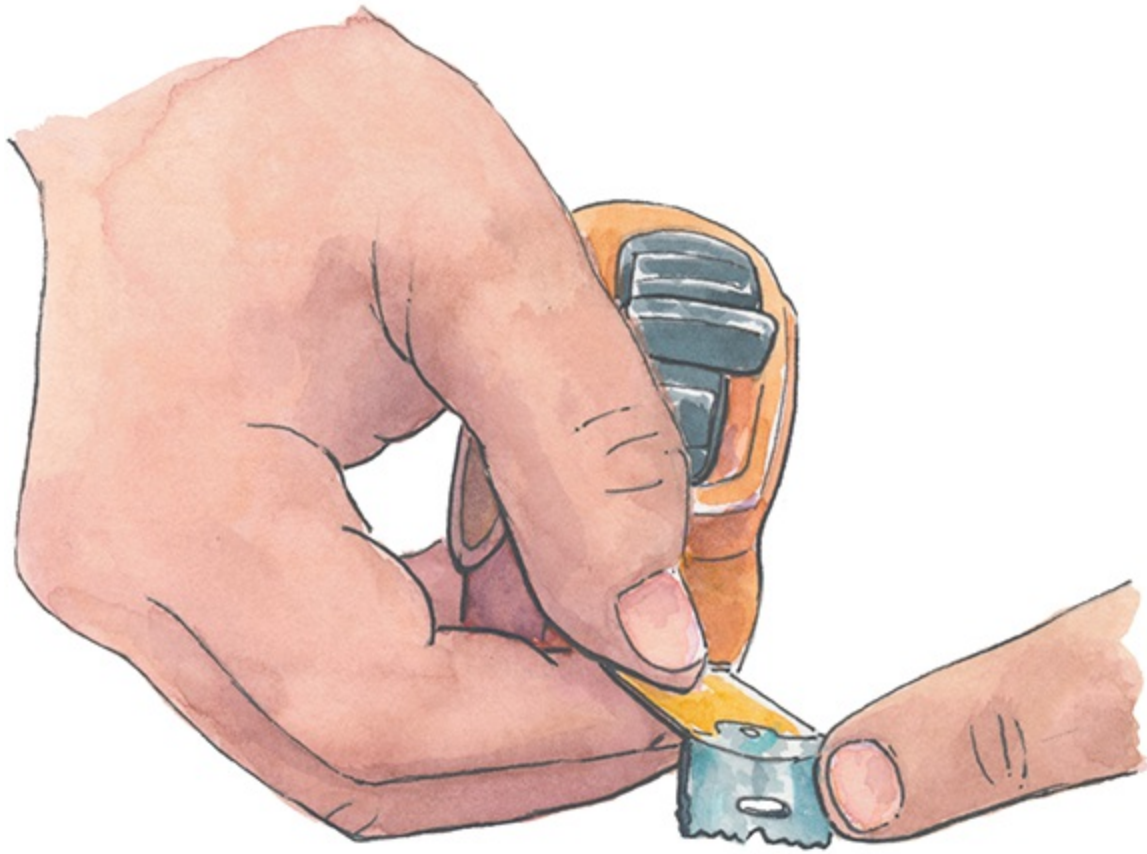
★ USE THE END HOOK SLOT ON A TAPE MEASURE FOR UNASSISTED MEASURING

There is a small slot in the end hook of most tape measures. That slot is there to grab onto the head of a nail or screw. That way, if you're by yourself and need to measure a set point on a flat surface that would normally require someone holding the tape, you can sink a screw or nail, hook the end of the tape measure into this slot, and securely and accurately measure from there. [LB]



★ **USE THE SERRATED EDGE OF YOUR TAPE MEASURE TO SCRATCH A MARK**

Have you ever noticed the serrated bottom edge of the end hook on your tape measure? If you're using the tape measure and don't have a marking tool at hand, you can press this edge into your workpiece, scratch it back and forth, and make a mark. **[LB]**



TIPS MY DAD SAYS

Words of wisdom from our maker dads. Pin this up in your shop so that the collective wisdom o' dad is always close at hand.

- If you don't have time to do it right, when will you have time to do it over?—**DSCOTTHEP**
- There is nothing more expensive than a cheap tool.—**DAVID STEVENS**
- Rust, fire, and explosions are the same process, taking place at different rates.—**MARK CRANE**
- Whenever I got overwhelmed, my dad would say, "You know how to eat an elephant, Kevin? One bite at a time."—**KEVIN DEVANEY**
- If you don't have the right tool, make the right tool.—**PAT FIZENBERGER**

- If it's stupid but works, it isn't stupid. **–BALLOONDOGGLE**
- If it ain't broke, take it apart, and have a look at how it works, then put it back together, and if it still ain't broke . . . hooray! **–LINDSEY BOARDMAN**
- Don't tell your mom. **–GARY SANDERS**
- All that crap you collect is worth nothing if it's not organized so you can find what you need when you need it. **–KALAXY**
- Never tap a gauge harder than you would tap the bridge of your nose. **–DAVID SEITZ**
- Force it to fit; paint it to match. **–DAVID SEITZ**
- If at first you don't succeed, get a bigger hammer. **–DAVID SEITZ**
- Don't be afraid to ask for help! **–MEGAN DURANT**
- My father (a lawyer) told me: "Company culture is driven from the top—if it's the people who make the product, you're good; if it's the people who sell the product, you're OK. If the accountants take over, look for another job, and if the lawyers take over, run as fast as you can. **–ALDEN HART**
- Unless size is an impediment, bring the broken part with you when seeking a replacement. **–ANDREW PLUMB**
- Estimate the time, expense, and number of supply runs required for a project intuitively. Then triple it, and plan accordingly. **–SEAN RAGAN**
- Teaching a good work ethic, teamwork skills, and diligence is just as valuable as showing someone how to use a drill press or a soldering iron. **–LIBBY BULLOFF**
- Never point out a problem without providing a few alternative solutions. **–RICHARD GOULD**
- The joy of making something with your hands is the greatest feeling there is! **–KELLY HOLLAR**

This list was boiled down from responses to an internal Make: staff mailing,

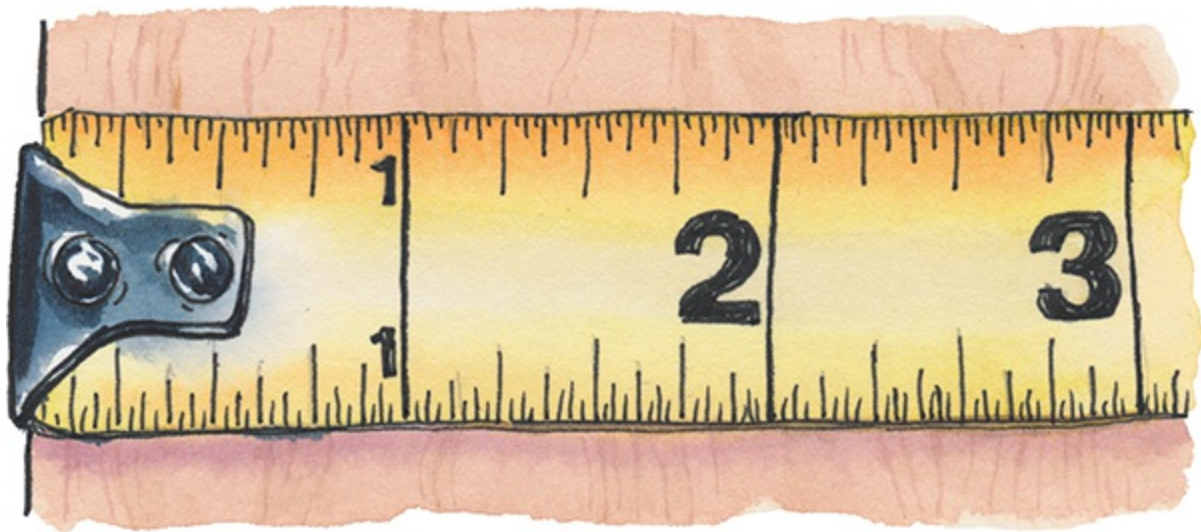
asking for dad tips, and a similar discussion on the Make: website.

★ **USE A TAPE MEASURE NAIL GRAB TO SCRIBE A LINE**

If you sink a screw into the center of a circle you wish to scribe, you can use the slot on the measure's end hook (called a nail grab) to help you scribe a circle. With the screw securely in the slot, hold a pencil steady at your desired radial distance and move the tape while keeping it taut, to scribe your circle. **[LB]**

★ **UNDERSTANDING THE TRUE ZERO HOOK FEATURE**

That riveted metal tab that holds the end hook on the tape has travel in it for a reason. If you'll notice, the inch marks on the tape actually start $\frac{1}{16}$ " short. That's because the thickness of the hook itself is $\frac{1}{16}$ ". So, if you take an inside measurement (pressing the hook end against the workpiece you're measuring), you will get an accurate measurement. But also, if you hook the end onto a workpiece, the play in the rivets will move the hook out to compensate for hooking onto the material, creating a $\frac{1}{16}$ " gap between the hook and the tape, allowing for an accurate measurement. Always make sure to pull the tape taut when making an outside measurement to make sure the end hook is fully extended. **[LB]**



★ **CREATE QUICK MEASURING STICKS**

If you do a lot of woodworking and make many of the same cuts over and over, create some measuring sticks for the common lengths that you cut. Attach a large washer on one end that overhangs the edge to form a stop for holding the stick in place while you are scribing off the length. [DFJ]

★ **PLAYING CARDS IN THE SHOP**

YouTube maker Nick Ferry swears by using playing cards in the shop. Because playing cards are reasonably thick, coated card stock of a known thickness (11.5 pt stock or 0.0115"), you can use them, singly or in stacks, to raise and shim a workpiece to a specific distance when drilling or cutting. [NF]

★ **USE THE CASE OF THE TAPE MEASURE TO MEASURE**

You are likely already aware of this, but the base of a tape measure's plastic or metal case always has a number on it indicating its exact length. Knowing this, you can use the case

itself when doing inside measurements where you would otherwise have to bend the tape into a 90-degree angle and sort of guess the exact mark where the tape would hit the mark. Instead, you can use the case itself to measure all the way to the corner, adding the length of the case itself to the number you get with the tape measurement.

★ **QUICK-DRAWING LINES CLOSE TO THE EDGE**

To draw a straight line close to the edge of a workpiece, hold your pencil in your hand and keep your fingers in exactly the same position while you follow the edge with the tip of your finger along the workpiece as you mark the line. [JD]

★ **QUICK-DRAWING LINES FARTHER FROM THE EDGE**

If you need to draw a series of parallel lines farther from the edge of your workpiece, use a yardstick, ruler, or a piece of wood. Hold your pencil to the ruler at the desired distance from the edge and use your other hand to hold the ruler against the edge of the workpiece as you run the line. A tape measure works for this, too, but it gets more difficult the farther away you get from the edge. [JD]

★ **FINDING THE CENTER**

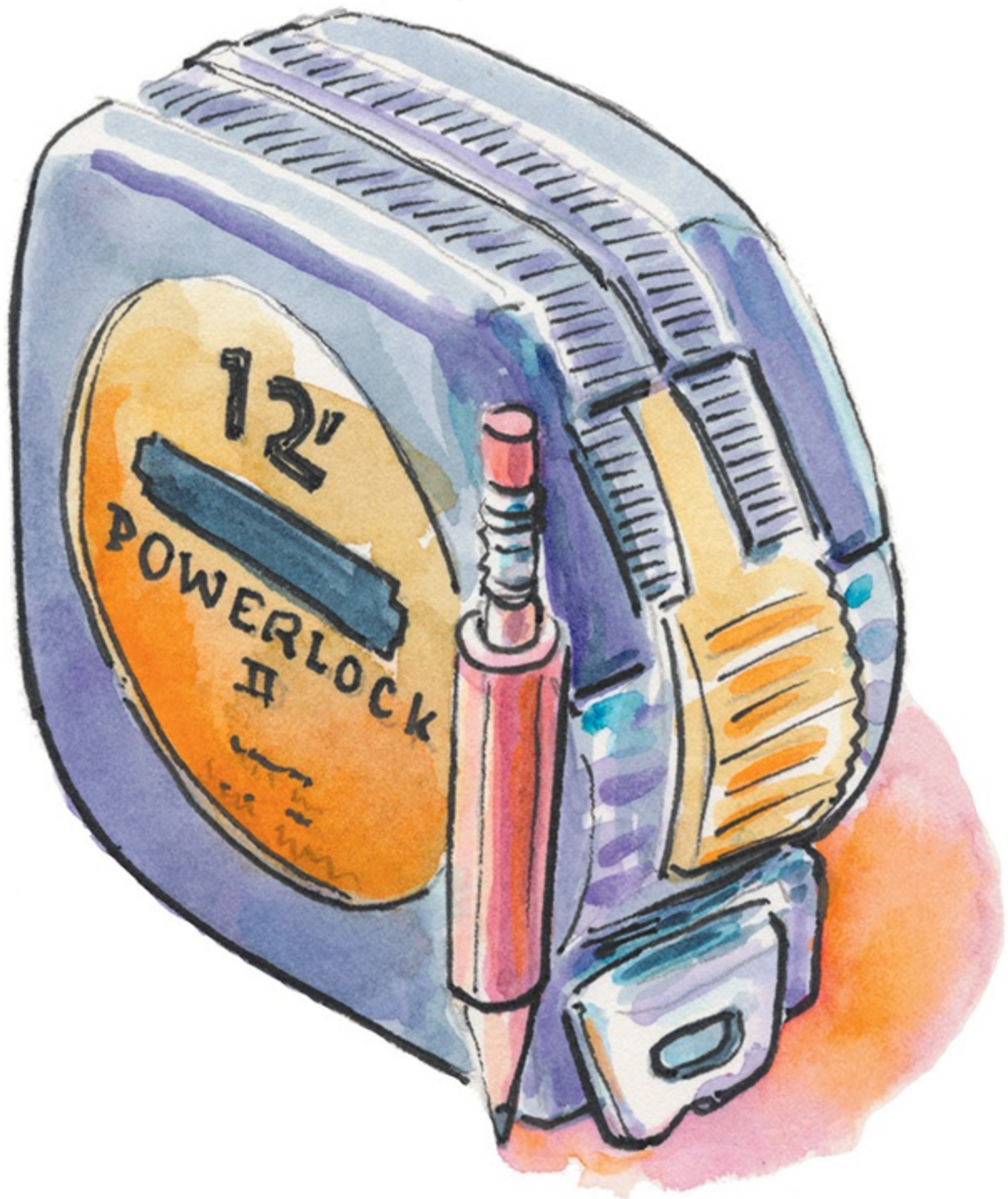
If you can find the balancing point in the middle of a piece of dimensional lumber, you have also found its rough center. Hold your hands parallel under the board and move them toward the center. When the board stays level, you have found the rough center. This technique comes in handy if you don't have anything to measure with. [JD]

★ **MAGNETIZE YOUR TAPE HEAD**

Want to create a hands-free end to your tape measure? Glue a neodymium (rare earth) magnet to the outside of the hook on your tape measure so that you can attach the hook to metal surfaces for single-person measuring, picking up dropped tools, and similar tasks.

★ **ADDING A MARKING TOOL TO YOUR TAPE**

If you want to add hands-free marking capability to your tape measure, glue a piece of plastic tubing to the measuring line of your tape measure so that it can fit a small length of pencil.



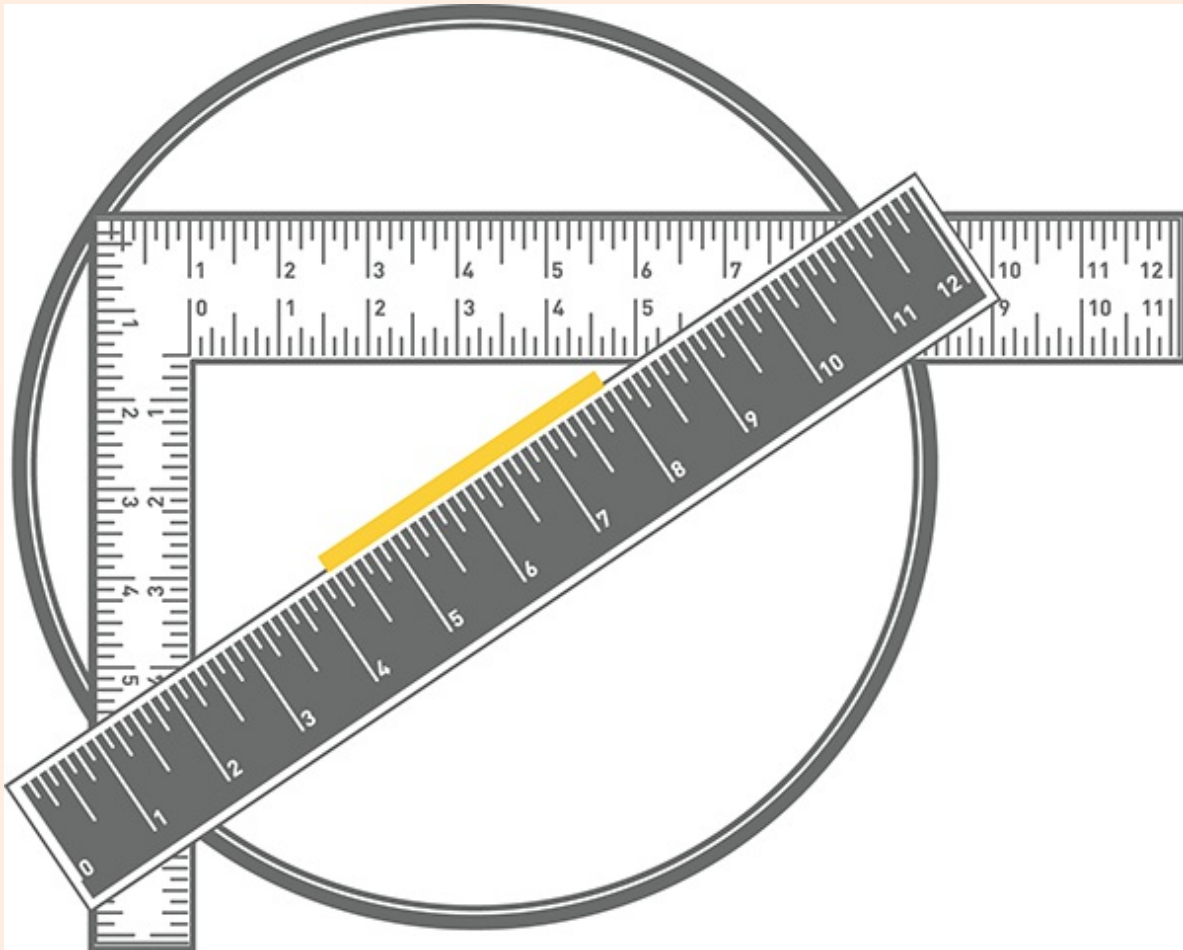
FIND THE CENTER OF ANY CIRCLE

If you need to drill a hole in the center of something circular, you'll have to find the center first. You could buy a fancy center-finding tool, or you can use simple measuring tools and these easy methods to mark the point.

CARPENTER SQUARE

Step 1

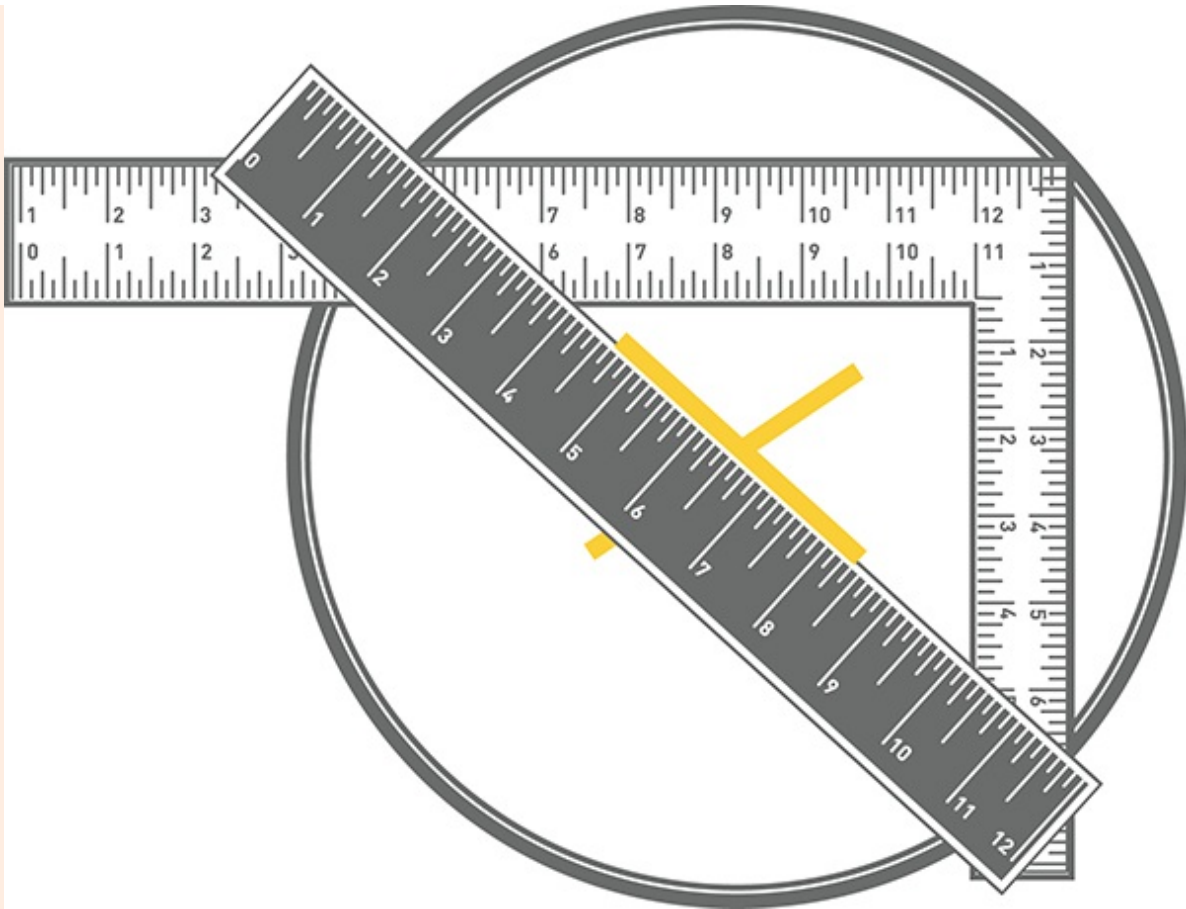
Place a carpenter square on the face of the material with the outside corner on the edge of the circle. Trace the outside edge of the square on the circle to draw two perpendicular lines across the circle.



Step 2

Use the straightedge to draw a third line perpendicular to one of the others. Then, using the square as a straight edge, draw lines from one end of the parallel lines to the opposite end.

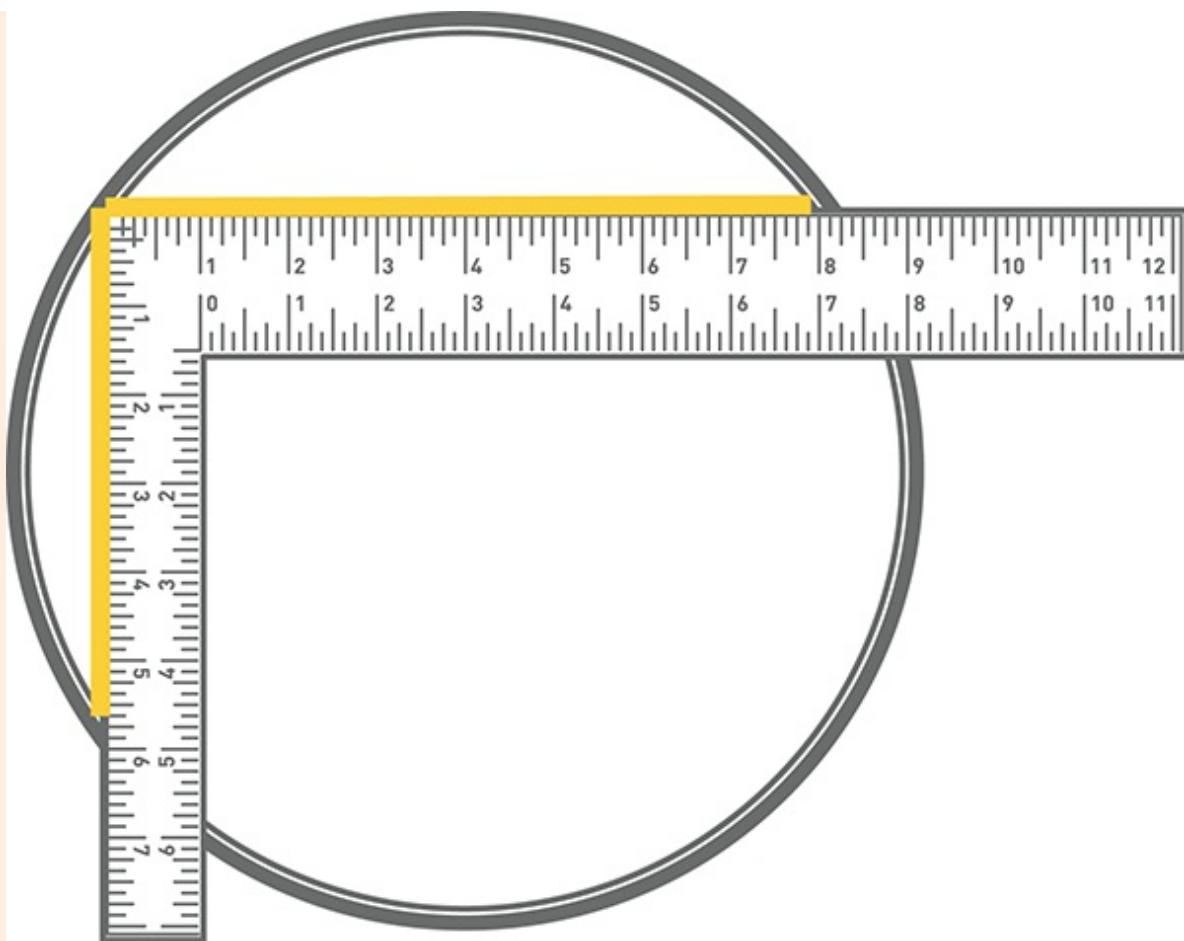
Don't have a carpenter square? Use a piece of paper, a book, or anything with a precise right angle to make your marks



CARPENTER SQUARE AND RULER

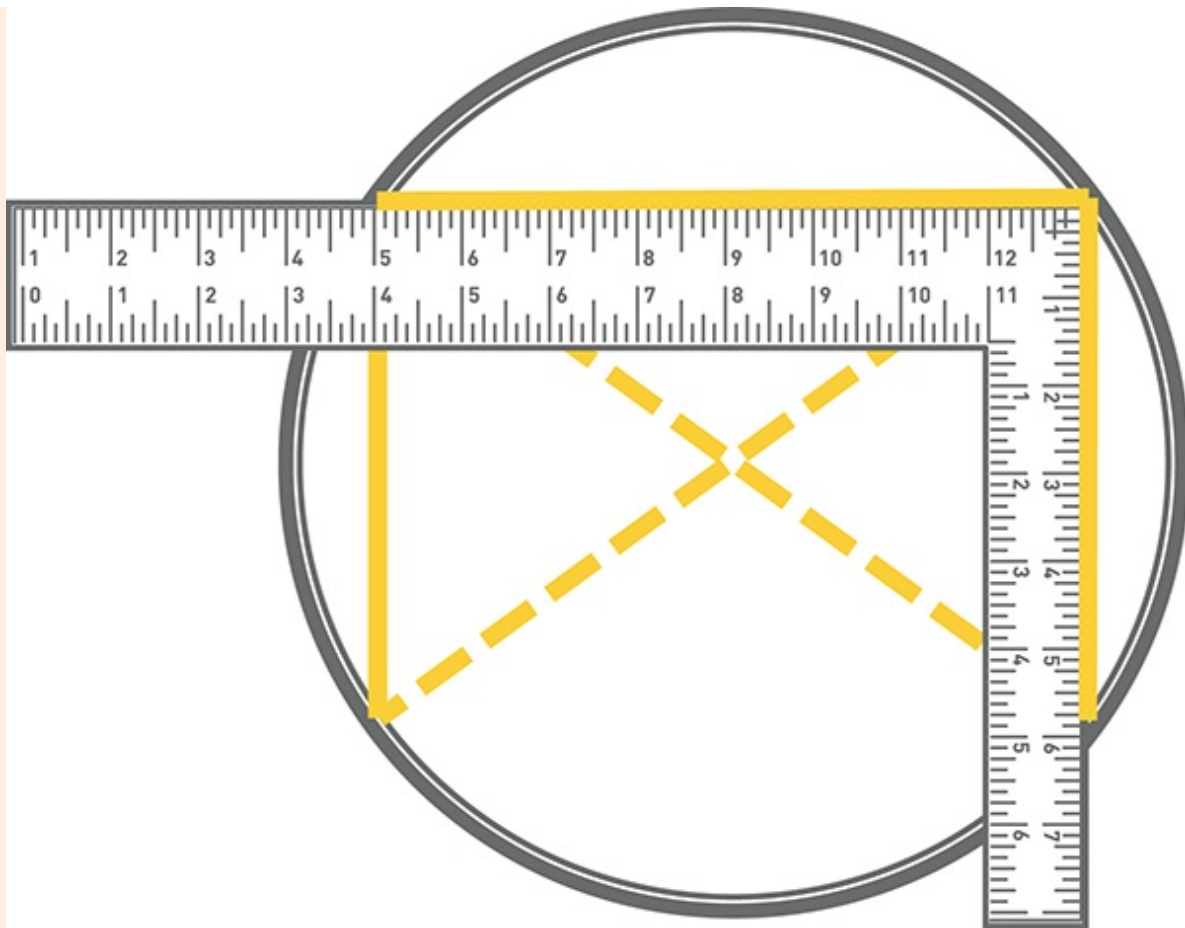
Step 1

Place a carpenter square on the face of the material with the outside corner on the edge of the circle. Lay a ruler across the square where the edges of the square touch the outside edges of the circle. Draw a line along the inside edge of the ruler.



Step 2

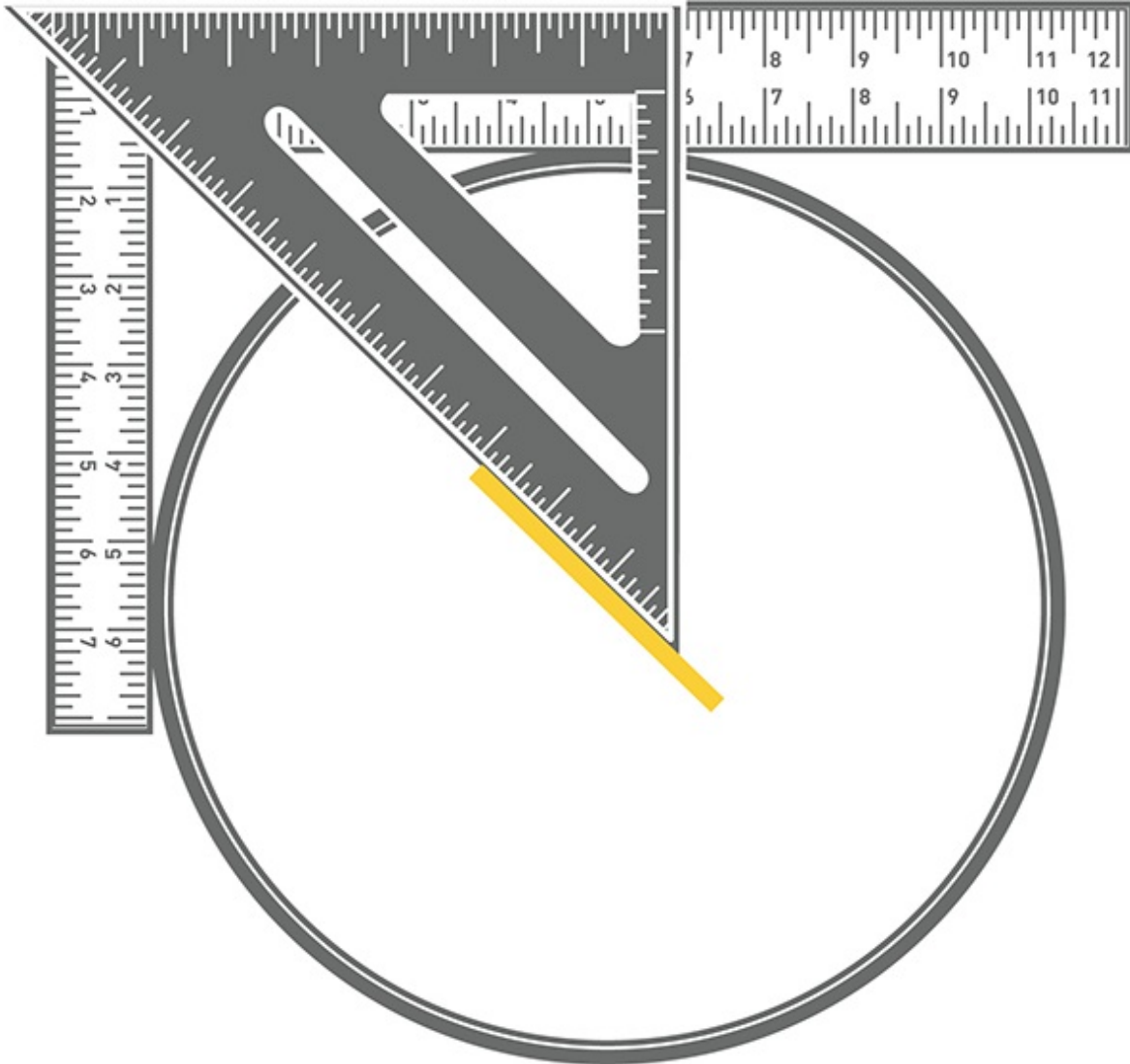
Rotate the squares and repeat Step 1 to draw another line.



CARPENTER SQUARE AND SPEED SQUARE

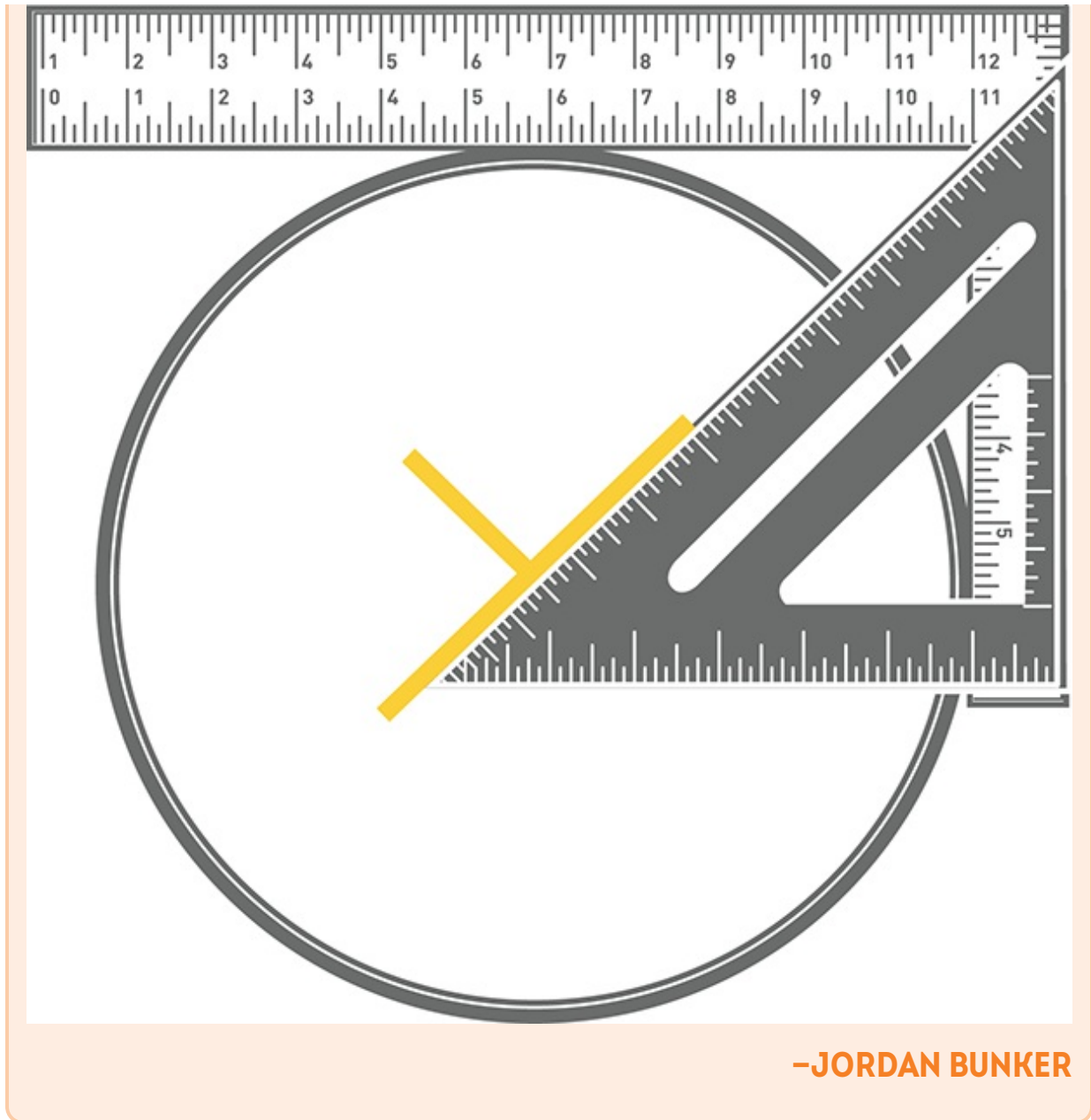
Step 1

Place the inside edges of the carpenter square against the edge of the circle. Place the base of a speed square against the carpenter square and align the angled side with the inside corner of the carpenter square. Draw a line along the angle of the speed square.



Step 2

Rotate the material and repeat Step 1 to draw another line.



—JORDAN BUNKER

★ RETRIEVING A TOOL WITH A TAPE MEASURE

Here's one from master maker Izzy Swan. When he needs to pick up a tool, or some hardware or other metal-based object that he dropped from a ladder, behind a cabinet, or otherwise out of reach, he keeps a rare earth magnet attached to the side of his tape measure. If he drops the object, he places the magnet on the hook of his tape measure, extends it, and

retrieves the item. The magnet and the tape are even strong enough to pick up something as heavy as a hammer. **[IS]**

★ **LONG DISTANCE MEASURING AND POINTING WITH A TAPE MEASURE**

On Stanley FatMax series tape measures, you can extend the tape for up to 11 feet and it will stay rigid. This allows you to use the tape measure as a giant pointer—for example to indicate features on a roof, trusses, gutters, and so on.



★ USE A DIGITAL SCALE FOR MEASURING MULTI-PART EPOXIES

The ever-clever Andy Birkey weighs in with this great tip. When measuring multi-part epoxies, resins, and the like in very small batches, supplier-provided measuring cups can become inaccurate. At these quantities, a little bit more or less can make a big difference in the quality of the resulting mix. For such small-batch measuring, use a digital scale. Pour the first part in to the desired weight, zero it out, and add the second part. Perfect. [\[AB\]](#)

HOW TO USE A SPEED SQUARE

Let's take a quick look at the speed square—a tool that you may already have but may not fully understand. While made for framing carpentry, a speed square can be indispensable in many situations that require measuring and marking.

WHAT IS A SPEED SQUARE?

A speed square (aka a “rafter square” or “triangle square”) is a measuring multitool. Made of steel, aluminum, or plastic, this common carpenter's tool combines a ruler, a try square, a protractor, a line-scribing tool, a common-width board-ripping guide, and a saw guide for making accurate 90-degree and 45-degree cuts with a hand or circular saw. A speed square's main uses are:

- as a Try square, for quickly measuring a line perpendicular to the edge of a board (hence the word square in the name),
- as a Miter square, for accurately marking 45 degree angles, and
- as a protractor, for easily finding and marking various common angles, especially roof rafter pitches and angles for stair stringers (the vertical supports on a stairway).

The speed square was invented in 1925 by Albert Swanson. Swanson was a carpenter in a small town outside of Chicago. He wanted to create a device to make it easier to quickly determine roof pitches. After he created the speed square, other carpenters began asking him for one, and the Swanson Tool Company was born. Speed Square is actually a trademarked name, but like Kleenex, it is often used as the generic name for this class of tool. Stanley's has a similar tool called a Quick Square and Irwin's is simply called the Rafter Square.

HOW DOES IT WORK?

"The Basics on a Speed Square" video on YouTube's Classic Work channel clearly runs through most of the key features of the speed square and how one might use it in day-to-day angle measuring and cutting, and in determining pitches.

WHAT CAN IT DO?

Here is a little more detail on the various functions and applications of the square.

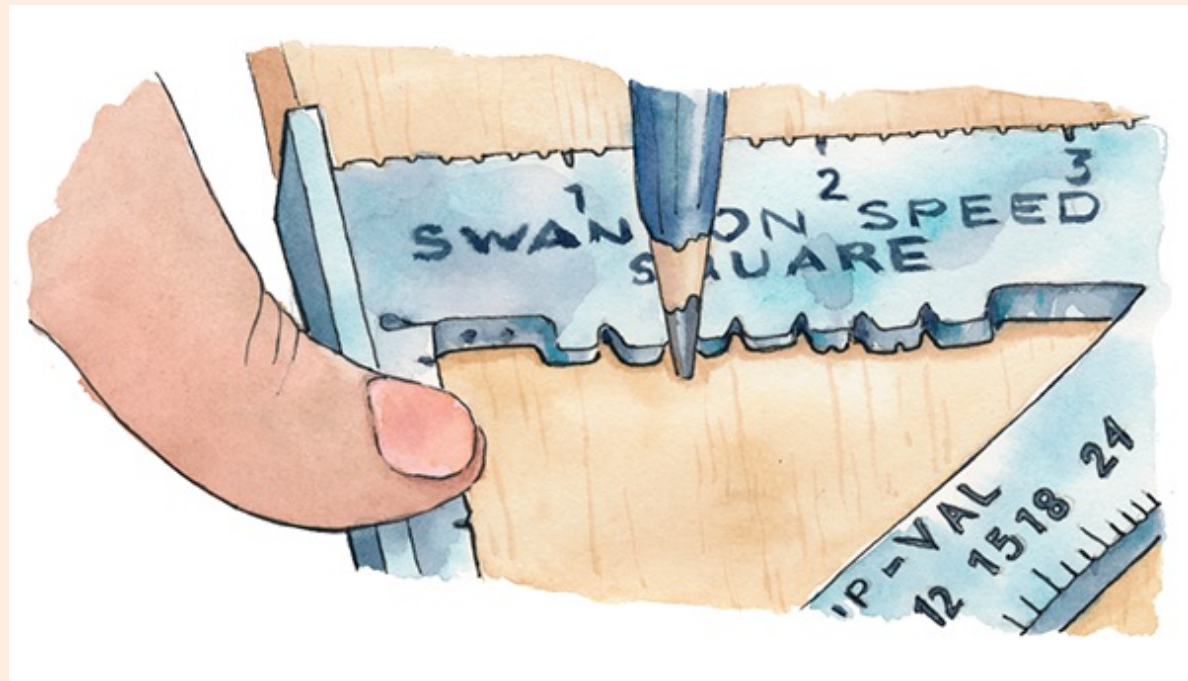
Marking

The most commonly used application of the speed square is as a try square. The tool has a lipped fence along one right-angled edge that allows you to hold the square firmly against a board. This allows you to easily and accurately scribe a line along the other right-angled edge that is perfectly perpendicular to the board's "factory edge." You can also use it in this mode to scribe 45-degree angles along the angled edge of the tool (i.e., the base of the triangle).

Measuring

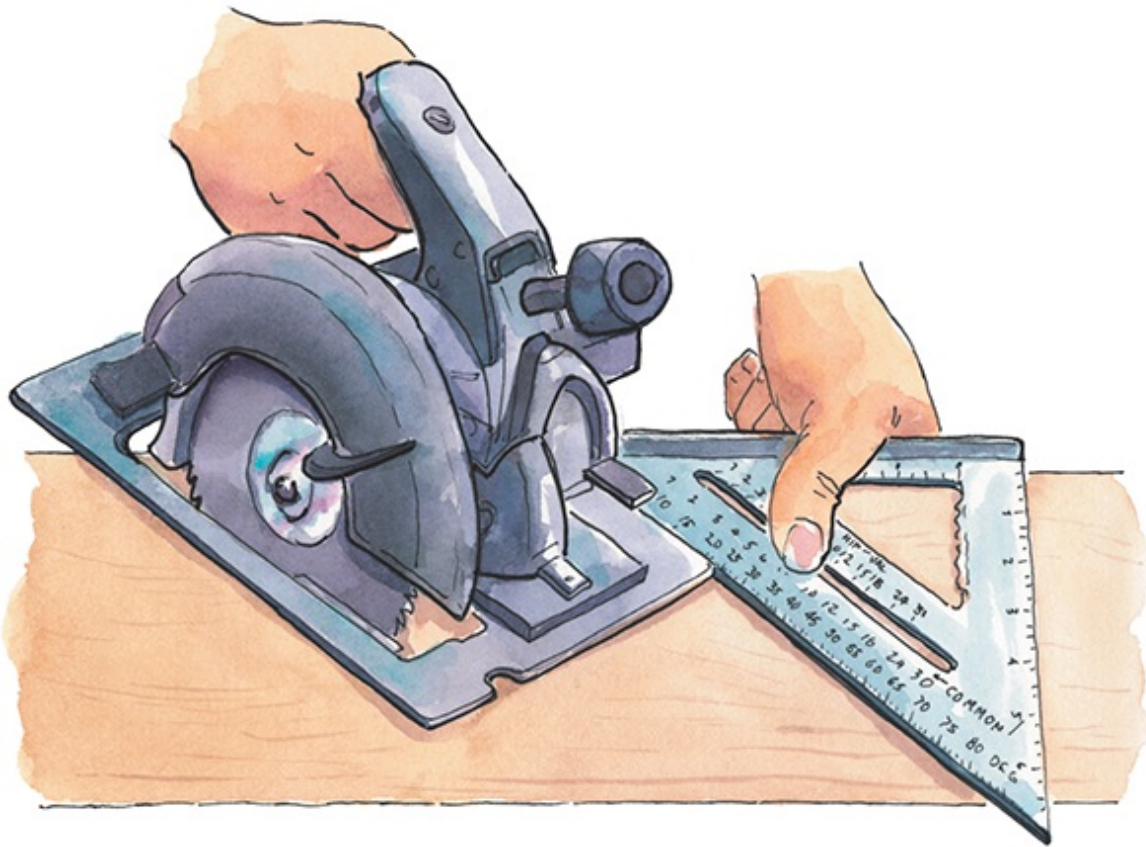
Along one of the right-angled edges of the square is a conventional imperial ruler that is either 7" or 12" (depending on the model of speed square). This ruler is used for measuring cuts. Below this ruler, in a triangular cut-out, is something called the scribe bar, a series of notches at $\frac{1}{4}$ " intervals. To easily scribe a rip or trim line along a board, you simply hold your pencil in the desired notch and run the fence along the edge of

the board to make an accurate mark down its length. You can also use the right angle of the tool to check internal angles for accuracy.



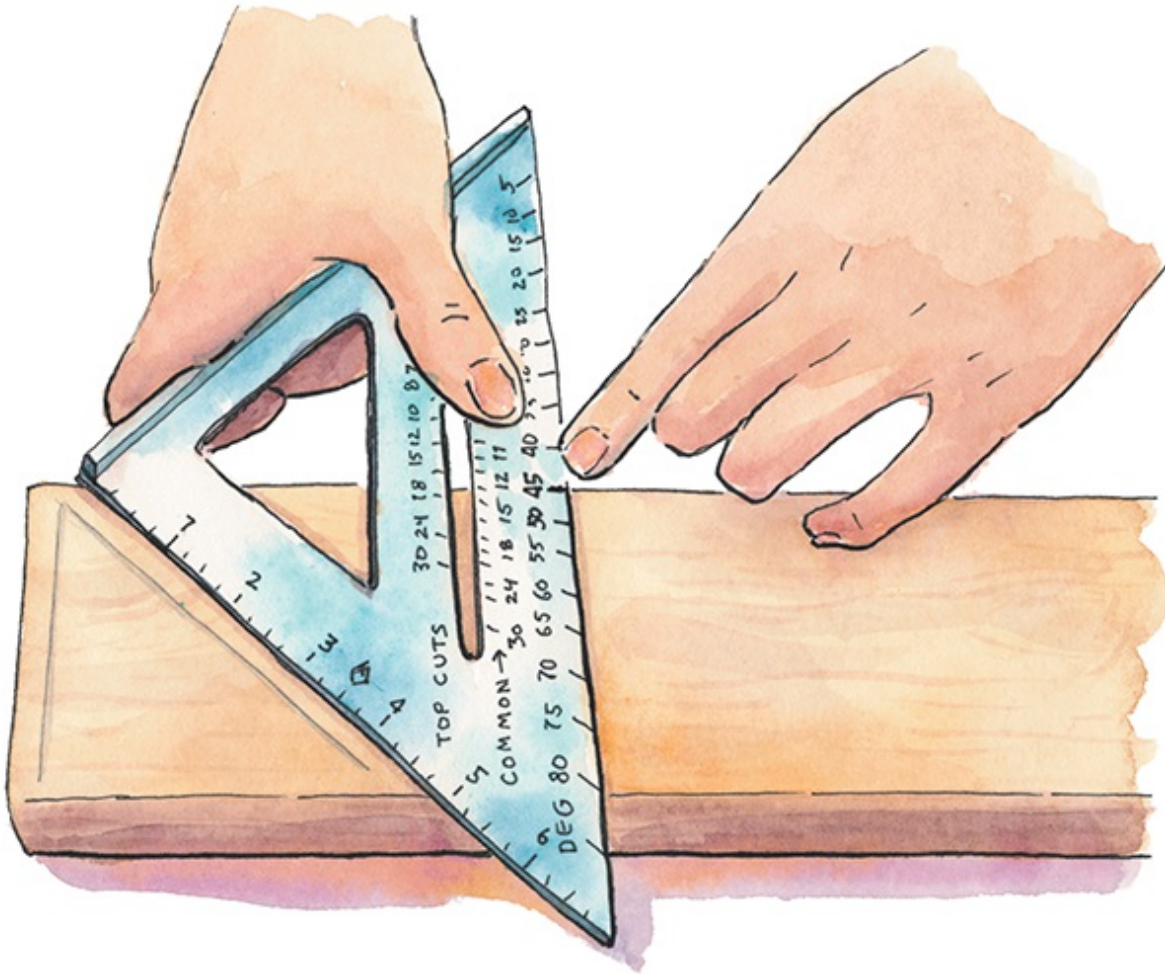
Saw Guide

One of the other common functions of the speed square is as a guide for cross-cutting lumber at an accurate 90-degree or 45-degree angle. By firmly holding the fence against the edge of a board, you can use the other right-angle or 45-degree-angle edge as a fence for your hand or circular saw.



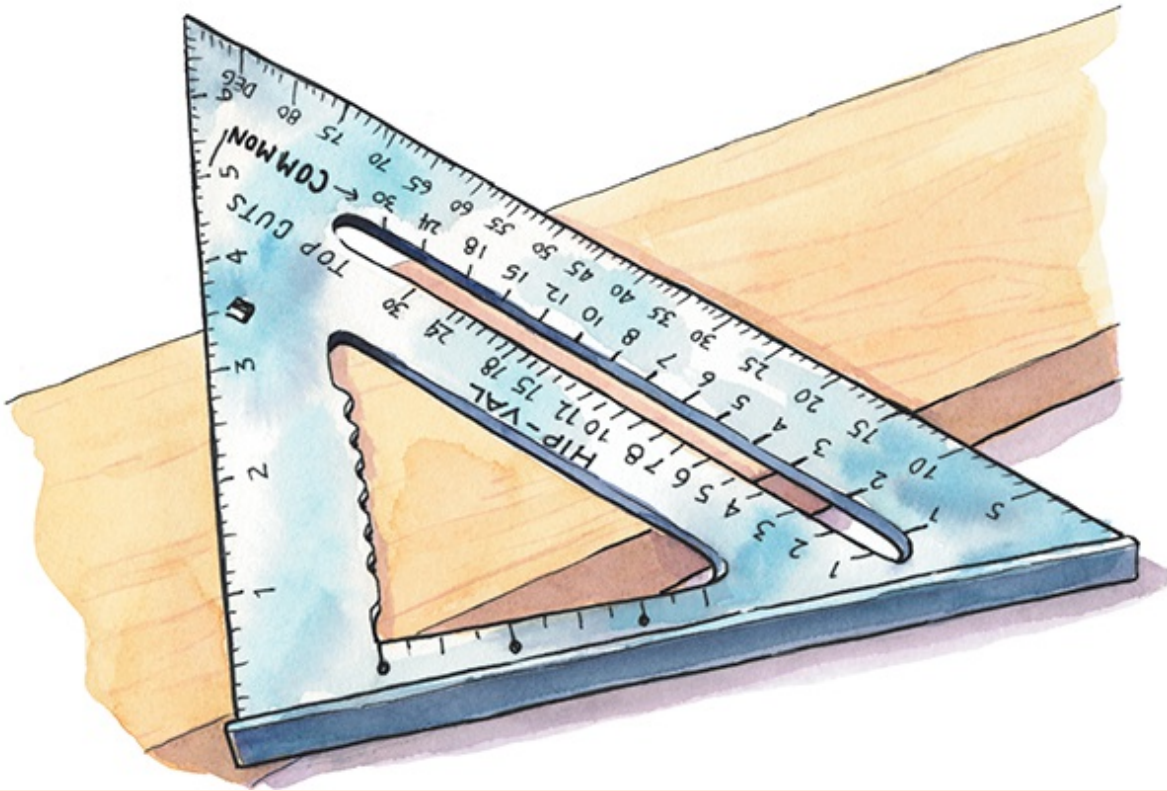
Protracting

To use the protractor feature, you first find the pivot point marked in the 90 degree corner of the square. With the pivot mark on the factory edge of your board, you pivot the bottom of the tool (where the protractor degrees are marked) and move it to the desired degree (let's say 45 degree) on the same factory edge. The pivoting edge of your square is now at a 45 degree angle to the factory edge. Mark that angle and you're ready to cut.



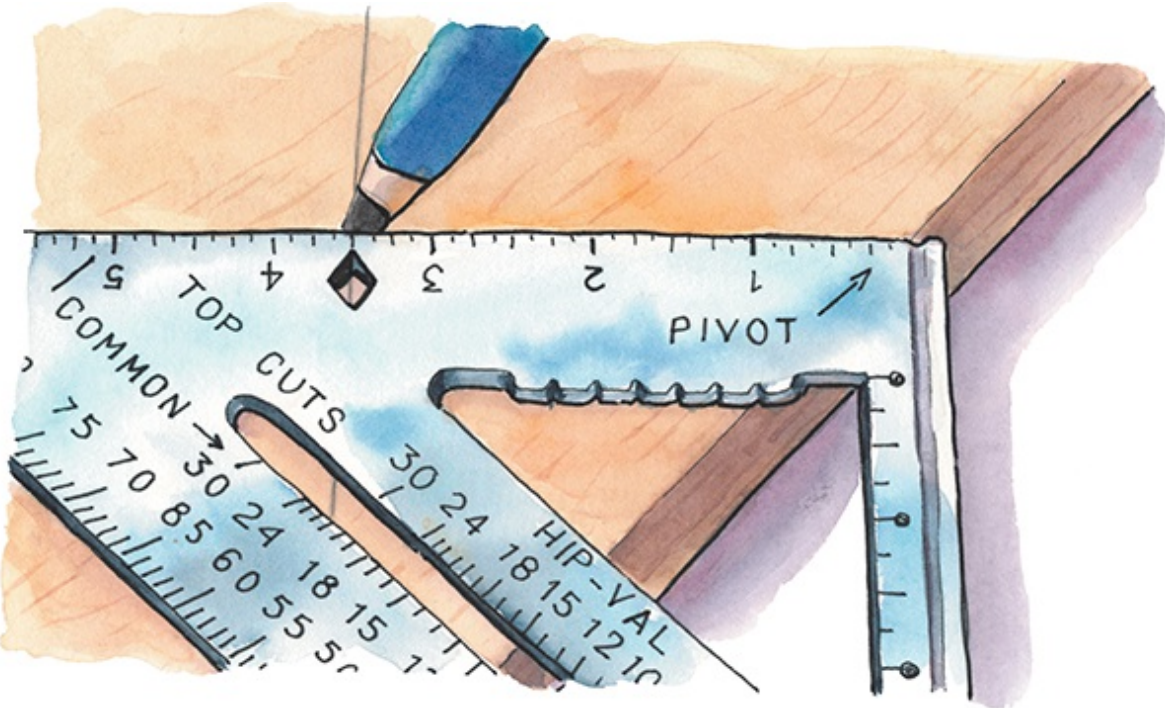
Measuring Pitches

Part of the speed square's role as a protractor, and its original mission as a tool, is in quickly finding common (and uncommon) rafter angles for the pitches on roofs. This is accomplished by use of the main protractor and two specialized protractor angle guides on the inside of the tool. The guide directly above the protractor is marked Common. On it, common roof pitches are indicated as the rise in inches, over a 12" run, for common rafters from 1" to 30". So, in this example, placing your square at the Common - 3 mark would mark the angle of a 3" rise over a 12" run. Above this guide is another, marked HIP-VAL. This stands for Hip-Valley and refers to the rise over a 12" run for hip- or valley-type rafters. Explaining the entire process for doing this quickly becomes too convoluted for this overview. If you want to know more, see the "For More Information" section a bit further on in the sidebar.



Other Cool Features

The Swanson Speed Square has a patented feature, the diamond cut, which is a diamond-shaped cut-out on the ruler edge of the tool. This is used for squaring on a line scribed across the board so that you can then make a perfect 90 degree line from your scribed angle to the edge of the board.



You can also use a speed square as a make-do level when you find yourself without a proper bubble level. You do need a plumb bob, but you can improvise one with a string and a nut (or some other suitable weight).

For More Information

I managed to find a copy of the infamous little, blue Speed Square manual that ships with every Swanson Speed Square in the archives of the Oak Lawn Public Library (Oak Lawn, Illinois, being the home of the Swanson Tool Company). You can also locate a copy with a web search. A little more accessible for the newbie is Stanley's Quick Square Instruction Manual, also available online. The Stanley manual does a great job of explaining all of the different roof types, includes a glossary of terms, and shows you how to use a square to find the correct pitch for different types of roofs. There's also a brief piece called "How to Use a Speed Square" on The Family Handyman that shows you a simple method of finding a roof pitch with a level and a speed square. Classic Work, the YouTuber who did the above speed square basics video, also has a video demonstrating how to frame rafters with a speed square.

4

MARKING

Written communication likely began when early humans scratched simple marks into dirt with a stick. Marking things is the beginning of moving ideas out of our heads and into the physical world, to commit their measure, and to render and refine their shape. In the realm of making, we return to simple scratches, marks, and basic numbers to communicate the size and shapes of the materials we have designed. How and where we make such marks can mean the difference between a project being a success and one that's a frustrating failure. While "Measure twice; cut once" may be the golden rule of making, if you don't properly mark that measurement to begin with, your careful measuring will be for naught.

★ MARK WITH A RAZOR, NOT A PENCIL

Make:'s video producer, Tyler Winegarner, shared this one with me. Maker Andy Birkey is a big proponent of marking cutting lines on a workpiece with a razor knife instead of a pencil. He claims you get 300 percent greater accuracy. But, as he points out, razor knife marks can also be hard to see on certain materials and finishes. No worries. Just rub some nearby sawdust over the mark and it will "light up" sufficiently so you can see it. [TW]

★ REVIVING MARKERS

Did you know that you can easily bring a dead, alcohol-based

marker (e.g., Sharpie, Magic Marker) back to life simply by removing the nib from the marker (however you get inside your particular pen) and depositing a few drops of isopropyl alcohol onto the felt material? It is usually the solvent the ink is mixed with that dries out before the pigment does.

★ **PAINT OVER TOOL MARKINGS FOR GREATER VISIBILITY**

From a site called “Sawdust Girl” comes this smart tip. The markings on Sawdust Girl’s blue, plastic, pocket hole tool were not very visible, so she slathered some white acrylic paint over the area, and then wiped the surface clean, leaving paint inside all of the markings. You can do this with any tool that has unpainted markings or paint that has worn off over time.

★ **STAY WITH THE POINT**

To keep your marking pencil’s point sharper longer, twist it between your thumb and index finger while drawing it along. This way, you’re constantly re-pointing it while using it. [\[JD\]](#)

★ **SHARPENED TWO-TIPPED PENCILS EVERYWHERE**

Dave Picciuto of Make Something has a tip for always ensuring that you have a sharp pencil handy in your shop. Buy a box of eraserless pencils, sharpen both sides, and leave pencils at every work area of your shop. You’ll always find a pencil, and it will likely have at least one sharp point on it. [\[DP\]](#)

★ **SHARPIE INSTEAD OF ENGINEERING BLUE**

You can get a clear scribe mark on metal by first coloring the

area using a Sharpie. It's easier to find a Sharpie than to find engineer's blue! **[AL]**

★ **THE SQUIGGLY LINE OF UNTRUE**

Any time you have material stock that has an edge that you know is not true, mark it with a squiggly line on both sides of the stock. If you only use that marking convention (or another, if you prefer) to indicate an untrue edge, you'll know which edges of your material you can trust and which you can't. **[AB]**

WHAT I'VE LEARNED ON MY OWN

My dad died before he could pass on any workshop knowledge. So, I've had to learn on my own. Some tips I've run across that have saved me pain (both physical and mental):

- Measure twice; cut once.
- Beer can shims are awesome (see Zen and the Art of Motorcycle Maintenance).
- If you have to force it, you're doing it wrong, and you're probably going to break it. Stop and think.
- Before putting all your weight on a wrench, consider what would happen if it were to slip, and adjust your position and direction of force accordingly.
- Take the time to move the ladder, get the right tool, or build the jig—it's quicker than a trip to the emergency room.
- Spend the extra money on good tools; you'll never regret it
- All that crap you collect is worth nothing if it's not organized so you can find what you need when you need it.
- If you haven't touched it for two years, throw it out or give it to someone who can use it (cleaning out the in-laws' house made a powerful impression).

- If you borrow a tool and break it, go to the store, buy the next grade up in quality, and return that. If you can fix the old one, you both win.

–MAKE: READER KALAXY

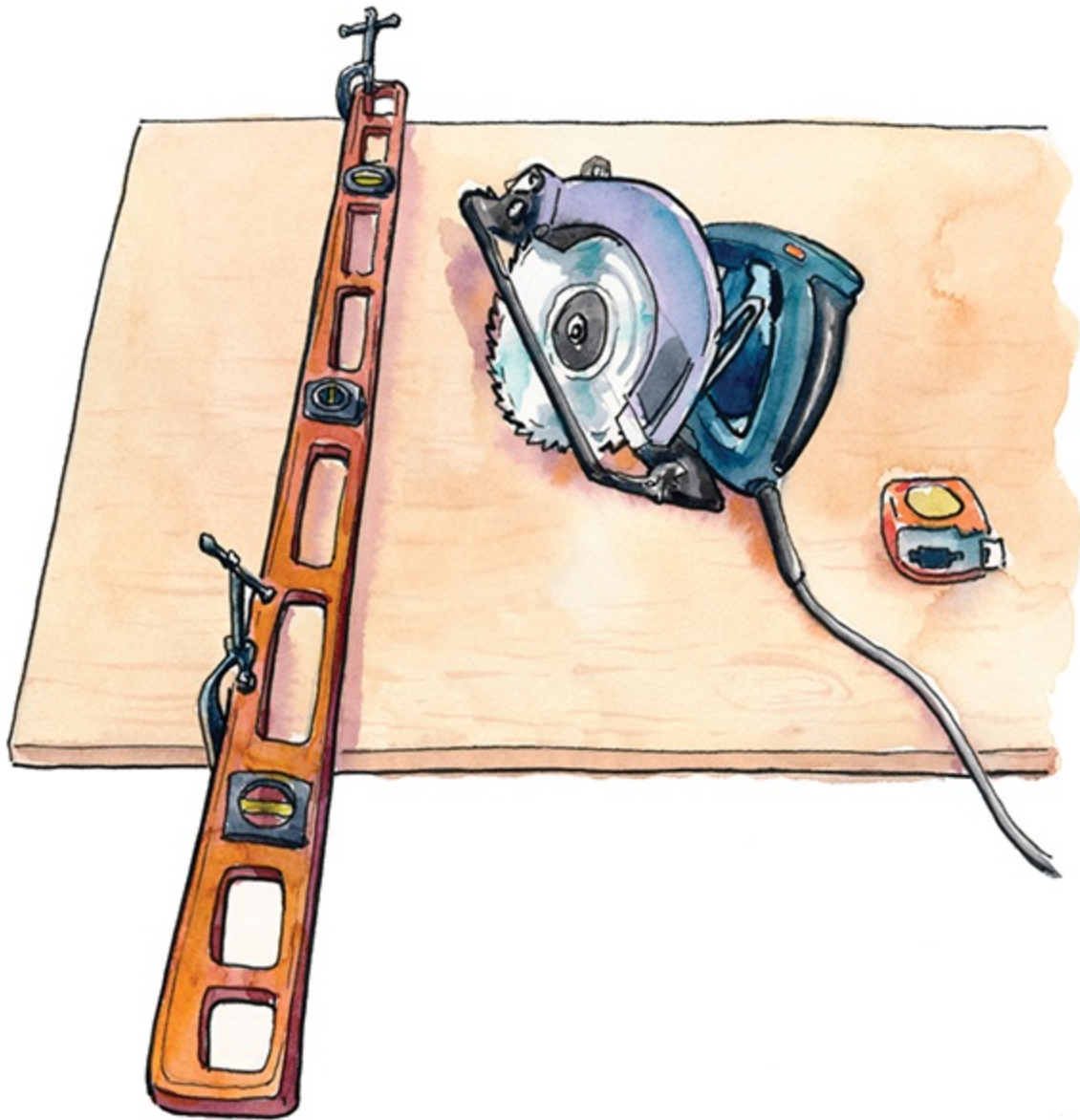
5

CUTTING

When the cutting starts, that's when things start to get serious. The talk and the planning are over, and you are now committing to your project. There's nothing like having designed something, planned out the build, measured everything (twice), and then, finally, beginning to fabricate the parts that you need. Knowing how to cut, knowing tricks and workarounds, and knowing how to work safely can make all the difference in the world in achieving project success. And always remember the first tip of cutting, as counterintuitive as it might be, that the sharper the cutting instrument is, the safer it is. Dull is dangerous (in cutting and in life in general).

★ **STRAIGHTEDGE TABLE SAW**

Lacking a proper table saw? You can improvise one with a circular saw; a straightedge, such as a metal level; and some clamps. Just make sure the straightedge is firmly fastened to the material you are cutting.



★ RIP AND FLIP

If you're ripping a lot of thin stock on a table saw, say for making furring strips, and you are worried about making a lot of repetitive cuts where your hands are repeatedly close to the blade, rip the stock halfway down, flip it over, and then rip the other half. Just make sure to keep the same side of the stock against the fence for both cuts. [JD]

★ **HAND SAWING WITH AN ORBITAL STROKE**

By way of Popular Woodworking comes this tip about adopting a handsawing stroke that greatly limits the amount of sawdust obscuring your cutline. Basically, you stroke down to cut into the workpiece and then lift the teeth of the saw out of the cut just a bit for the return stroke, and then stroke down again on the next forward stroke. By using this orbital sawing motion, you are pushing all of the sawdust away rather than pulling it up onto the top surface of the board on the return stroke.

★ **TIGHTENING A TABLE SAW BLADE**

It's easy to loosen and retighten the nut on the mandrel of a table saw blade by bottoming out an adjustable wrench on the far edge of the open throat of the saw and then pushing the blade away from you to loosen the nut. To tighten the nut once the blade is replaced, bottom the wrench out on the edge of the throat closest to you and then pull the blade toward you to tighten. [JD]

★ **WORKING WITH A DULL BLADE**

If you're working with a dull blade on your table saw (why are you working with a dull blade?), or are otherwise concerned that your stock might ride up while it's being cut, you can attach a wooden screw clamp to your fence right above the top of the stock. If the stock tries to ride up, the bottom wooden edge of the clamp will act as a stop. (And if it happens, time to sharpen your blade.) [JD]

★ **CUT A BENDABLE JOIN IN WOOD**

By making a series of angled cuts on one side of a piece of stock (at about 5 to 7 degrees) and then flipping it over and

spacing another series of cuts between the cuts on the other side, you can make the wood bendable. [JD]

★ **CREATE A RETRACTABLE POCKET SAW BLADE**

You can create a retractable pocket saw blade by removing the blade of a retractable utility knife and using it as a template to snap off the same length of hacksaw blade. Then drill a hole in the blade where the thumb-handle mounts and place it into the utility knife housing. You now have a retractable pocket saw.

★ **BUILD A SIMPLE PLASTIC BOTTLE STRING CUTTING JIG**

You can build a simple cutting jig for breaking down plastic bottles into plastic string using six washers, two screws, a piece of wood, and the blade from a plastic, school box pencil sharpener. Make two columns of three washers spaced far enough apart to hold the blade. Screw the columns into a piece of a wood with the blade sandwiched in between the first and second washer in the stacks—make sure to tighten the blade in place. Now, to break down a bottle, cut the bottom off with a utility knife and begin twisting the bottle through the blade to cut strips of the plastic. The resulting plastic string is surprisingly strong and can be used in all sorts of lashing and tying applications.



BRINGING THE LINE OFF THE PAGE

The tool I've kept the longest, and probably used the most, is my X-Acto knife. I first got it when I was 11, although I don't remember how I got it. At first, I was a bit afraid of its sharp point.

But then, I took it to my favorite material, which is paper. It let me make super-fine marks—more precise than a pen or pencil—and added new dimensions to the material. I could see through it and sculpt the flaps that came up from the cut. I had always loved drawing, but this tool let me bring the line off the page. It was especially great that this still felt like drawing, because you hold the knife the same way as a pencil and rolling it in your fingers changes the quality of the line like it would with a pencil. What's also magical is that with the knife, all I needed was a material or a surface. There was no need for ink, crayon, or marker, because the material itself would make the mark when I cut into it.

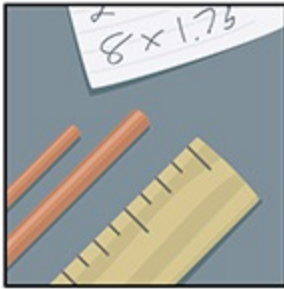


Since that time, I've kept my special X-Acto knife, though I've learned since then that getting new sharp blades is also really important. Old blades tend to catch, slip, and then cut where you don't want to—like yourself!

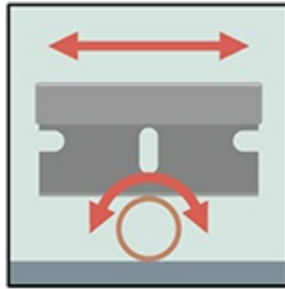
—JIE QI

Tricks of the Trade

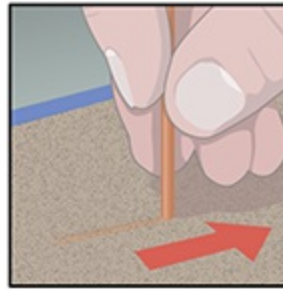
Tim Lillis (narwhalcreative.com)



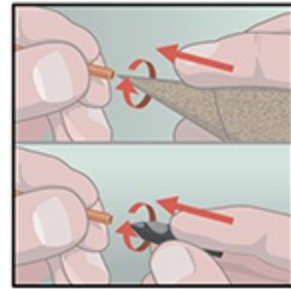
Dave Hrynkiw at Solarbotics shared a great trick to cut small-diameter copper pipe without a pipe cutter.



Roll the tubing under a razor blade. Roll back and forth, making sure that you're getting a full rotation on the tubing with each stroke.



To clean up the end, you can drag the pipe across a coarse sandpaper. Taping the sandpaper down to a table will ensure a stable, level surface.



If you don't have a deburring tool, you can use a cone of rolled up sandpaper or a countersink to smooth the edge.

★ MAKING A HOBBY-KNIFE COMPASS-CUTTER

If you have a compass that's designed to accept different markers and pens, you can also slot a hobby knife into it and turn your compass into a circle cutter.

★ REMEMBER ROUTER PROTECTION

Routers are very noisy and messy. Make sure you have eye and ear protection so the dust and noise don't impair you.

★ USE A CLIMBING CUT

Use a climbing cut—moving the router in the direction of the bit rotation—for sections that are susceptible to tear out (splintering). But be aware of the likelihood of the router pulling away fast. [\[JD\]](#)

★ LISTEN TO YOUR TOOL

Know the wood you are cutting into. Listen to your tool, and pay attention to how it looks, smells, sounds, and is behaving.

When routing properly, the router should be stable and steady, with no howling, jumping, or burning smells.

★ **CHECKING THE SQUARE OF YOUR SAW**

If you want to check to see if your chop saw is square, cut two pieces of wood on it at a 90-degree angle and then flip one of the cut pieces edge over edge and match the cut lines of the two pieces. If your saw is square, the cut should match perfectly with no space. If it's not a perfect match, you know that your saw needs to be adjusted. [JD]

★ **NEED TO GET A HACKSAW IN A TIGHT SPACE?**

If you have to cut something in a confined space that will not allow you to use a conventional hacksaw with a handle, take a hacksaw blade and thickly wrap one end with electrical, masking, duct, or other tape to create a handle. Hack away!

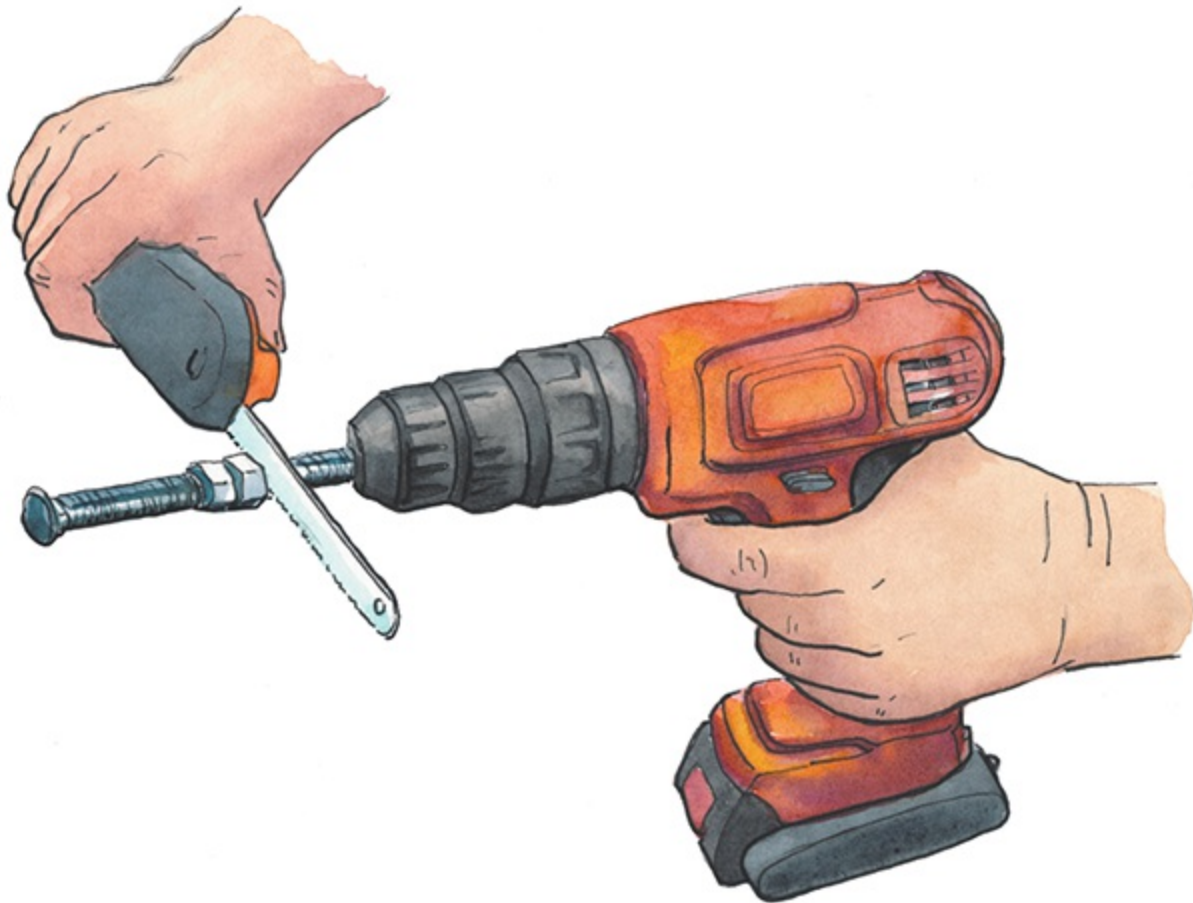
★ **USE A SHARPIE FOR CLEAR METAL SCRIBING**

You can get a clear scribe mark on metal by coloring the area first using a Sharpie. It's easier to find a Sharpie than to find engineer's blue! [AL]

★ **SHORTEN A BOLT WITH A DRILL**

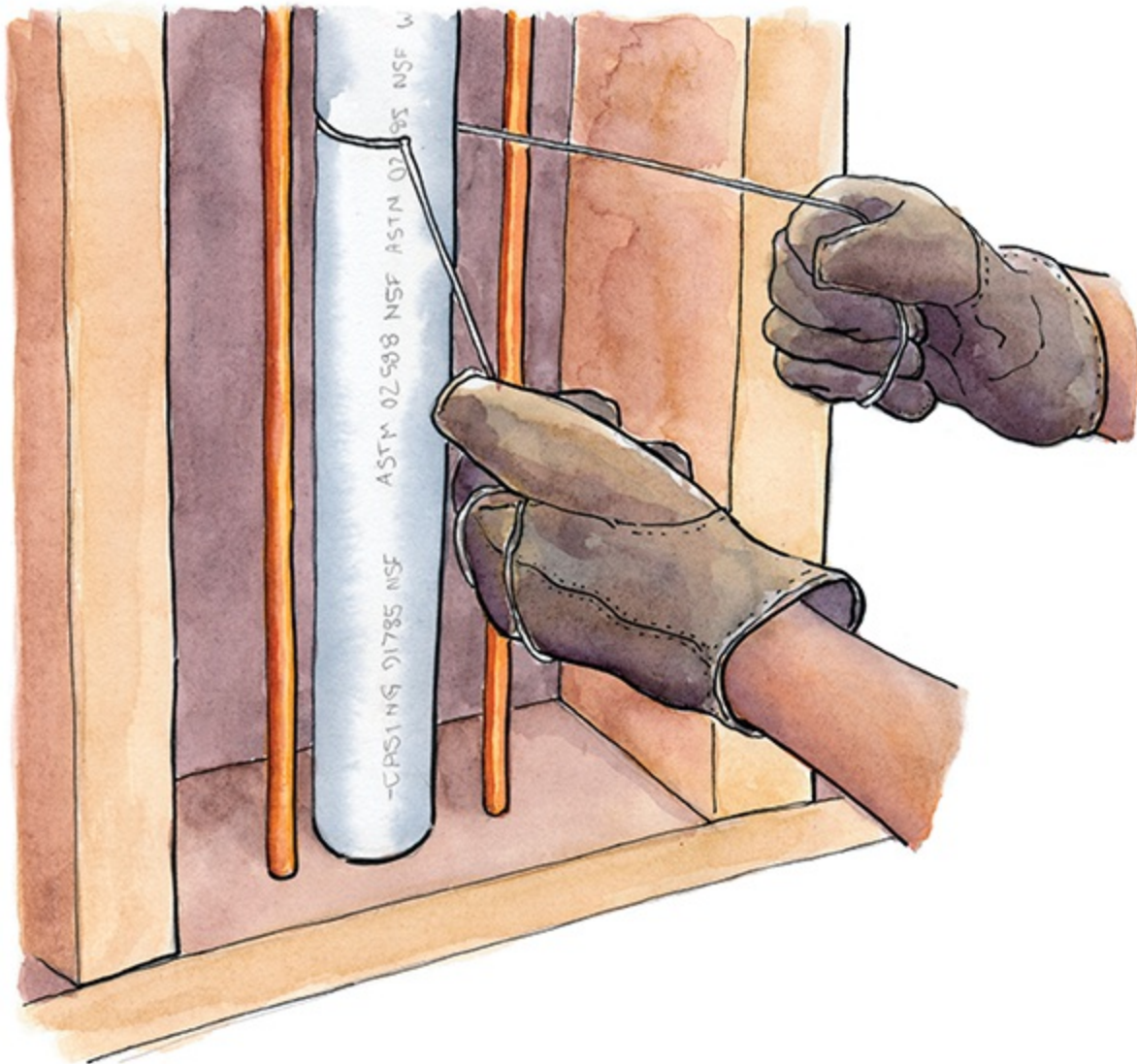
From Family Handyman comes this tip: "If you need to shorten a bolt, let your drill do the hard work. Spin two nuts onto the bolt, tightening them against each other. Then, chuck the bolt into the drill and hold a hacksaw blade against the spinning bolt. The nuts help to steady the blade and clean off burrs

when you unscrew them.”



★ CUT PIPE WITH A STRING

This gem about cutting pipe with a string also comes from The Family Handyman: “It’s almost as fast as a saw and fits into tight spots where saws won’t. To give the string a starting point, cut a shallow notch with a file or hacksaw blade. Then, simply pull the string back and forth to slice through PVC or ABS pipe.” This is also a trick used in scale modeling to cut plastic pieces with a string that you can’t otherwise reach with a hobby saw.



★ **USE TAPE TO PREVENT TEAR-OUT**

If you want a clean cut when using a circular or table saw, put some masking tape along the cutting edge (on the side where the blade will break through). It prevents chips and splinters (known as tear-out).

★ **HOLDING UP YOUR CUT PIECE**

Before you get to the end when you're cutting a big piece of wood, place something (a ruler, square, another piece of wood)

underneath the beginning of the cut, so that end stays up as you cut through on the other end. [JD]

★ SCORE AND BREAK FOAMBOARD

If you have a lot of foamboard to cut down, rather than having to saw all the way through the board, simply score one side, place a piece of wood beneath the cut line, and then cleanly break the board. [JD]

★ CUT POLYURETHANE FOAM WITH AN ELECTRIC KNIFE

Make: author Charles Platt suggests buying a cheap, electric carving knife for cutting polyurethane foam. He had previously tried other methods and was dissatisfied with the results. Then, he walked into a Jo-Ann Fabrics and saw them cutting big slabs of foam with an electric carving knife. He went right out and bought himself one (for about US\$25), and Charles lived happily ever after. [CP]

👊 KEN'S PUNCH

I was fresh out of design school when I started working at Mattel as a toy designer. I felt like I'd plucked the lucky gumball out of the corporate job machine. I was in a top-secret "think tank" of about a hundred super-creative people, all dreaming up new ideas for toys and games. There were designers, garmentmakers, chemists, machinists, tool and die makers, model makers, engineers, artists, electronics experts, and the list goes on. And I got to be part of this amazing team of toy makers!



For one of my first projects, I needed to make a series of carefully placed round holes in a deck of game cards. None of the standard hole punches were the right size. Ken Amamoto, one of the machinists, saw my predicament and offered to make me a custom punch. He took a piece of steel rod and drilled a deep hole just the right size for my project. He milled a slot in the side to work as an exit for the punched-out circles and then turned down the end to make a sharp conical tip with a thin edge all around. He then heated it with a torch until it was cherry red and quenched it in water (to harden the metal), and it made that satisfying hiss. “There you go, Bob!” he said, handing me the custom punch he’d made in less than 10 minutes! I was so grateful—and amazed.

That was 40 years ago. Ken passed away in 2011. I still have the custom punch and I think of him and his kindness every time I use it.

—BOB KNETZGER

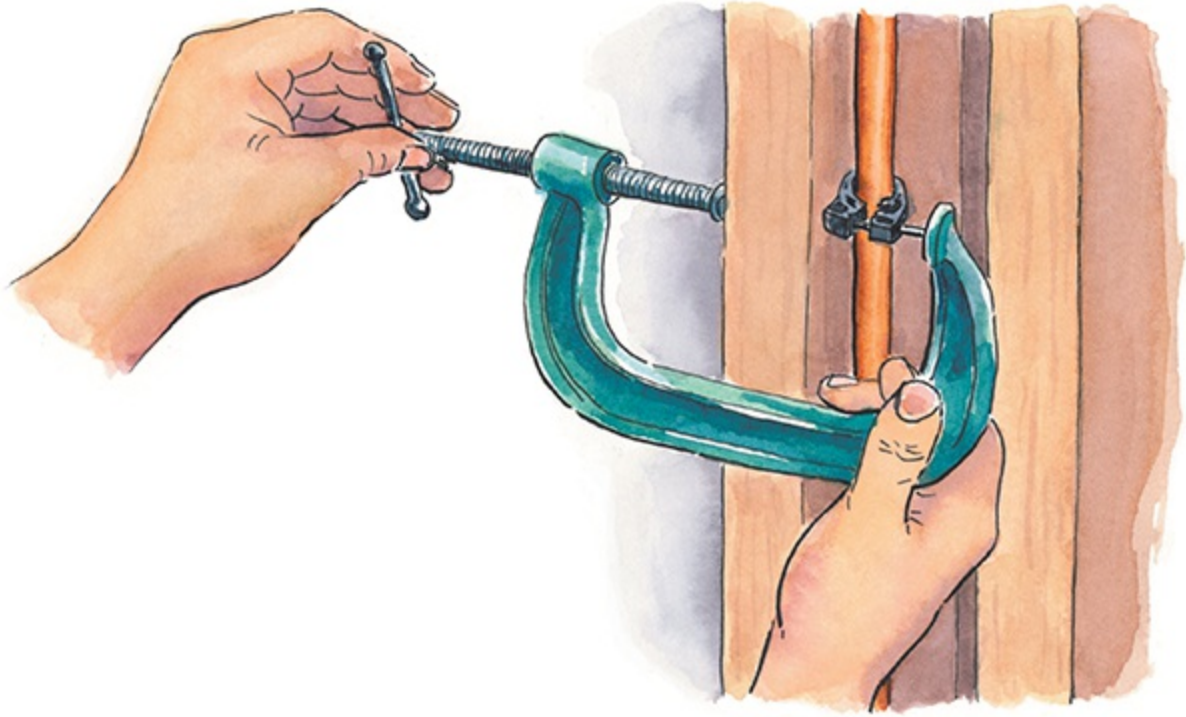
6

CLAMPING

The thing about clamps is that you can never have enough clamps. Seriously. C-clamps, bar clamps, pipe clamps, spring clamps, Quick-Grip clamps, and Bandy Clamps—they all come in handy at some point, so it's always smart to have lots of different types around. The good news is that places like Harbor Freight have cheap clamps. Whenever you're shopping for supplies, toss an extra clamp or two in your cart to add to your collection.

★ **DRIVE A NAIL WITH A CLAMP**

Trying to affix a brad or small nail in a situation where there's no room to swing a hammer? Try pushing the nail into the wood by screwing down a C-clamp. This trick comes from The Family Handyman.



★ **CREATE CHEAP CLAMPS WITH PVC**

In situations where you need lots of clamps for gluing a big job, have a clamping emergency, or want dirt-cheap shop clamps, this little hack can come in handy. Simply cut a ring of material from a length of plastic pipe—PVC drain pipe, ABS pipe, or whatever's available—and then cut a kerf in it. Voilà; you have a handy spring clamp. To add more clamping power, just cut a thicker ring.

You can also add heavy-duty rubber bands to introduce more tension, or if you want variable pressure, cut a hole in the C, top and bottom, and use a threaded rod, washers, and wing nuts to create an adjustable clamp.

Tricks of the Trade

Tim Lillis (narwhalcreative.com)



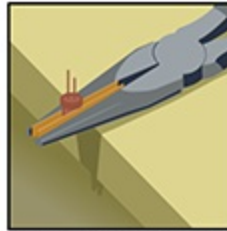
Andrew Lewis, journeyman maker, shared this trick to make a DIY vise/clamp with heat sink properties.



You'll need: some pliers and a rubber band. Yup, that's it. Maybe some tape.



You can use this setup to hold your work, especially useful if you're generating heat and don't have a "third hand."



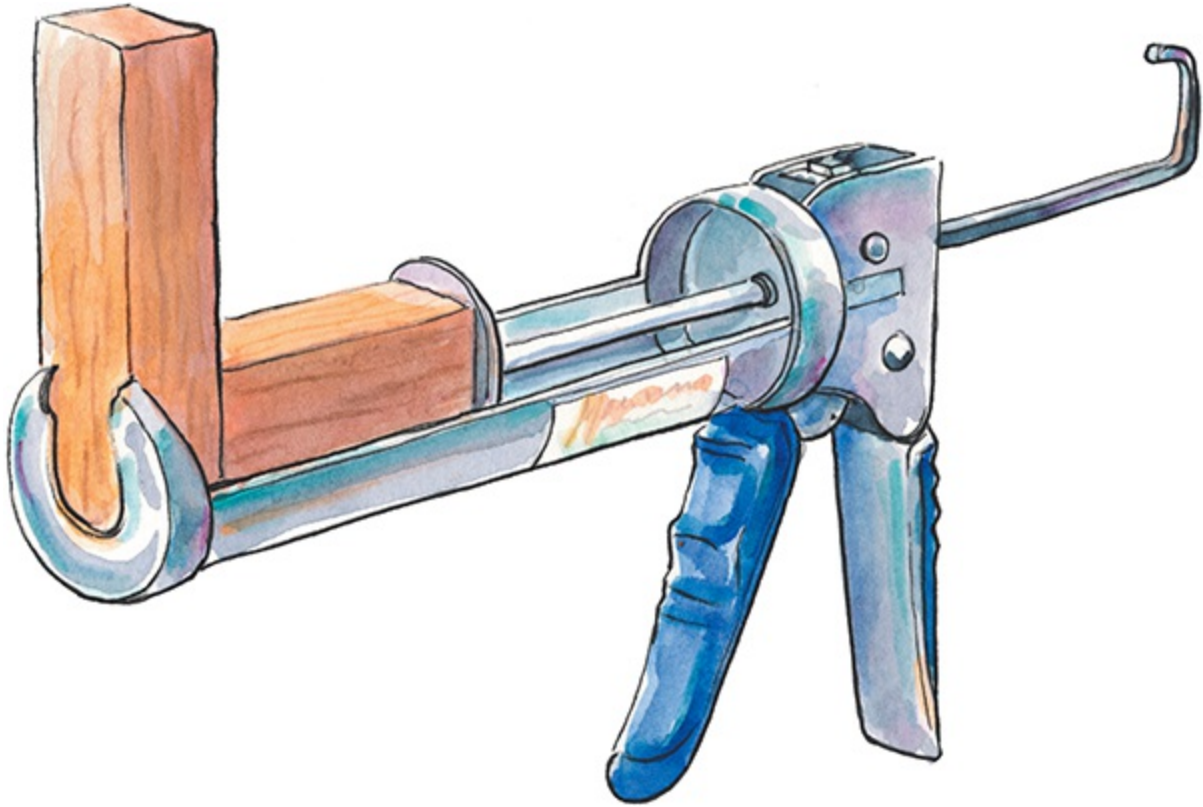
Add some copper tape in the jaws if you want a smoother surface that will still conduct heat away, or regular tape if you just want a smoother surface.

★ SPEED-HANDLING A CLAMP

Here's a classic carpenter's move to single-handedly open and close a metal C-clamp. With one hand, hold the clamp by the handle, leaving the rest of it free, and then just spin the clamp to open (or close) it.

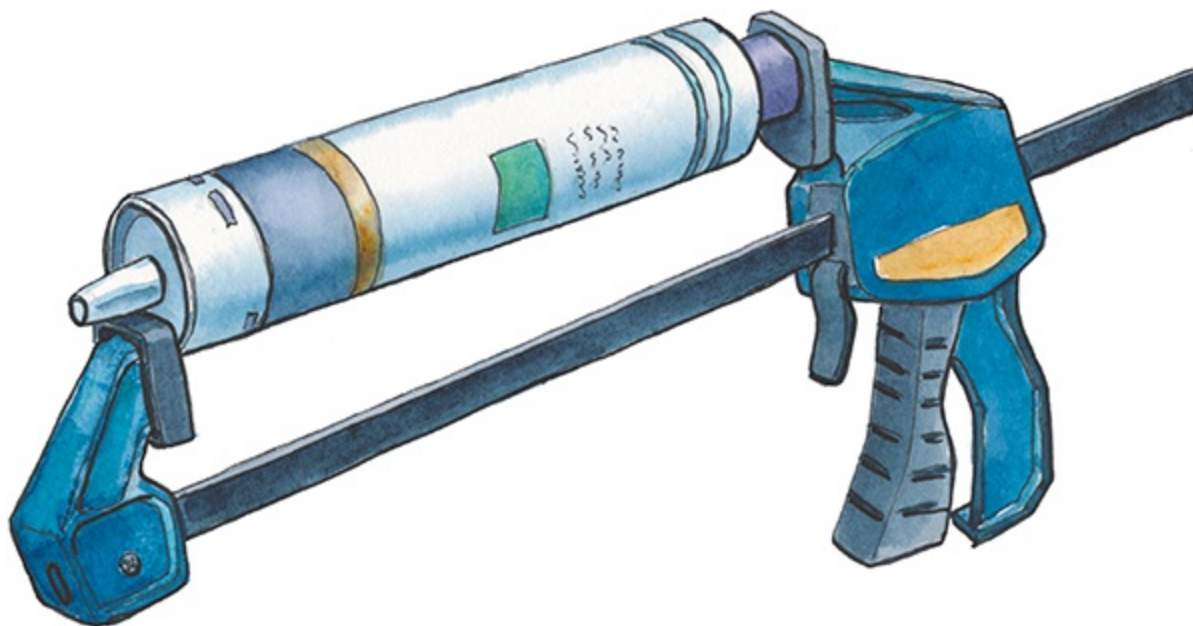
★ USING A CAULKING GUN AS A CLAMP

The idea is simple: need a bar clamp in a pinch and don't have clamps, but you do have a caulking gun or two lying around? Remove the tube of caulk, slot a few chunks of wood into the jaws of the gun, and you have a fairly effective emergency clamp.



★ USING A CLAMP AS A CAULKING GUN

If you have a tube of caulk but no gun, you can use a Quick-Grip bar clamp (with something on the back end to press into the caulk tube) as a makeshift gun.



★ USING LEATHER PADS FOR MORE FORGIVING CLAMPS

Linn from the Darbin Orvar YouTube channel buys scrap pieces of leather to create pads on various clamps and tool jaws where the metal of the tool might mar the workpiece that's being clamped.

★ EXTENDING BAR CLAMPS

Have you ever thought of extending the length of your bar clamps? It's actually easy to do. First, remove whatever rivets are holding the clamping mechanisms on the existing bar. Next, get some bar stock that matches the height and thickness of your existing bar. Then, simply move the clamps over and create a new stop for the clamps. You can do that by drilling a hole in the bar and installing the nuts and bolts hardware from your existing clamp. You can make bar clamps any length you want using this method.

🔧 **SEVEN TIPS FROM ANDREW'S DAD**

1. Always draw a picture, even if you think you know what you're doing.
 - If you're installing something in a room, do a rough sketch of the room and annotate with your measurements.
 - When a picture isn't enough, make a model.
 - When a model isn't enough, rethink the problem, ask questions, hunt down books, and so on. More research is needed.
2. Measure to design; design to measure.
 - In an ideal world, all your materials will be precise and all your cuts will fit perfectly. We do not live in an ideal world.
 - Over-designing structural, load-bearing elements is a good thing in prototype and one-off works.
 - Symmetry only really matters for visible elements of the design. See previous bullet.
 - If it needs to hold 100lbs of books, load it up with 200lbs of weight when you're done to see where it's going to bow or break.
3. Unless size is an impediment, bring the broken part with you when you're looking for a replacement.
 - The older the thing being fixed, the less likely you are to find an exact replacement.
 - Measurements only get you so far if you don't know exactly what you're looking for.
4. Lift with your knees!
5. Hit the right nail.

Corollary: Thumbnails do eventually grow back.
6. If a jackknife gets stuck in the wood you're whittling, do not pull harder to get it unstuck. It will bite you.
7. Always have a well-stocked first-aid kit (including a good pair of

tweezers for pulling out slivers of all kinds) and a fully charged fire extinguisher at hand—you will eventually need them. Replace what you use so it's there for the next time.

—ANDREW PLUMB

7

JOINING

Without the right connections, your projects are just piles of parts. Knowing the proper technologies and techniques to use for properly and securely joining materials together is a critically important part of engineering anything. Here are some ways for getting the most out of your mechanical connections.

★ **WELDING PLASTIC WITH A ROTARY TOOL**

Need to bond two plastic pieces together? Consider friction welding. Simply chuck a short length of plastic rod into a rotary tool. Apply the spinning plastic tip to your join and the friction will melt the plastic, forming a serviceable bond. **[MG]**



★ **CRAFT A TAPE-DISPENSING HAMMER HANDLE**

If you want to have some tape handy on the job, wrap a small spool of some electrical tape around the base of your hammer (or sheathed knife, and so on) and it's right there when you need it. [\[JD\]](#)

★ **FOLD YOUR TAPE FOR EASY RETRIEVAL**

When using cellophane, packing, or other thin tapes, never let the end of the tape rejoin the roll. Always fold over the end (or put it in a holder, which is what a tape holder is for). [\[JD\]](#)

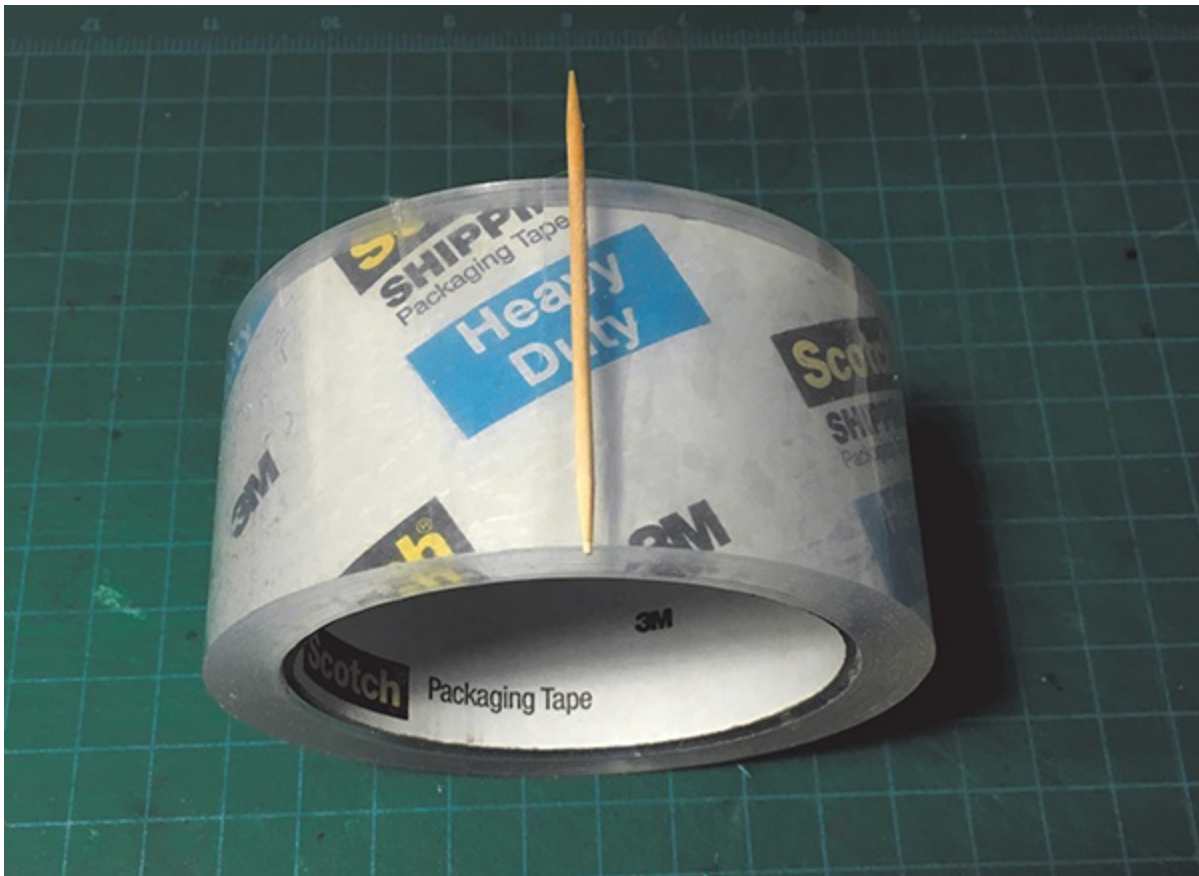
★ **TAB YOUR TAPE FOR EASY RETRIEVAL**

To keep from losing the end on your tape rolls, stick a plastic

bread tab on the end each time you are done. [\[JD\]](#)

★ **TAB YOUR TAPE WITH A TOOTHPICK**

There are many approaches to keep from losing the end of your tape roll and keep it accessible. The most common is to fold the end of the tape under or into a peak after you cut it. Or, some people use a plastic bread tab on the end. (See tips above.) I recently started placing a toothpick across the tape right behind where I plan to cut. I've used the folding and bread tab methods, but I find the toothpick method much easier to use. With folding, you have to cut the folded part off when you've applied it, and with the bread tab, you have to futz with its placement. With the toothpick method, you simply place the pick across the tape past where you plan to cut. The overhanging part of the pick even becomes a little handle for unwinding the tape the next time. You'll never have to dig for the start of your shipping tape again.



When I posted this on the Make: Facebook page, I got a raft o' crap from people saying "Just use a tape gun!", and arguing that the folding method works fine. I have a tape gun—a big, honking industrial gun—that came with a box of shipping tape. I hate it (and don't feel like buying another). For me, the toothpick method works perfectly and gives me way more control than the gun. All I can say is to try it before you judge.

★ REDUCING TAPE ADHESION

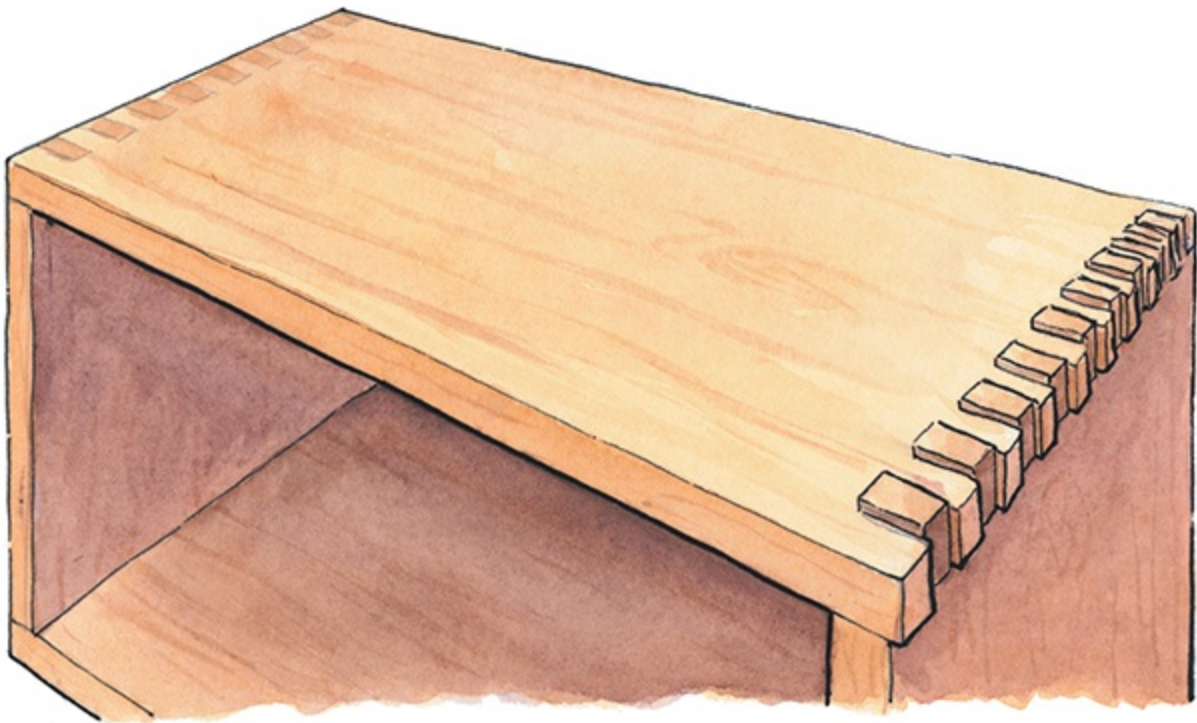
If you want to diminish the adhesion of gaffers and other types of high-adhesion tape (so that it can be more easily and cleanly removed), stick the tape onto cotton fabric (e.g., your t-shirt). The cotton fibers the tape picks up will lower the adhesion value. [JD]

★ TO DUCT TAPE, OR TO WD-40?

If it moves and it shouldn't, use duct tape. If it doesn't move and it should, use WD-40. [DR]

★ MAKE YOUR JOINTS PROUD

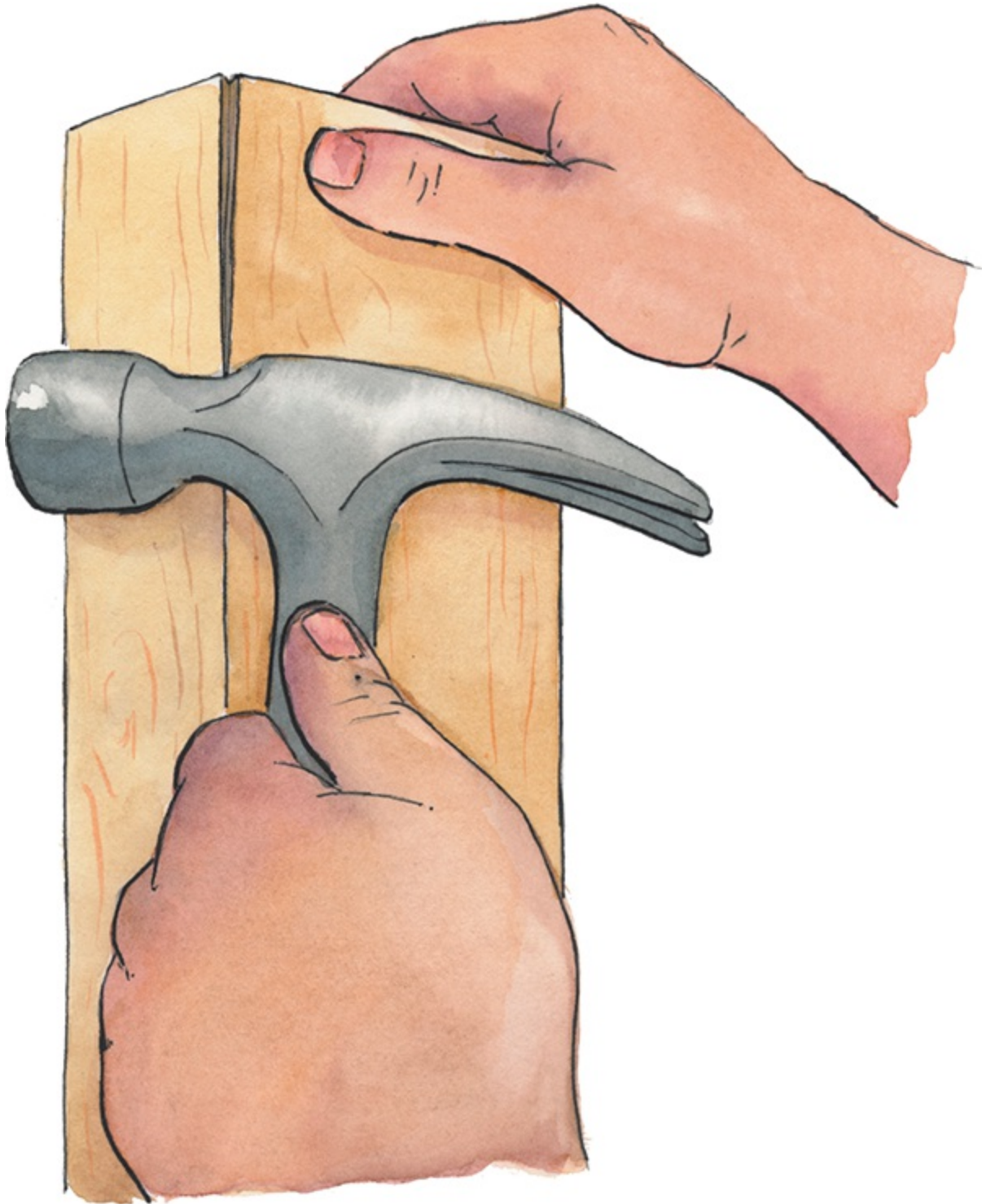
In one of Jimmy DiResta's project videos, he mentions his penchant for leaving his dovetail joints "proud." He's often commented on this practice. Proud in woodworking refers to letting the workpiece protrude over the edge. This allows you to sand or cut the piece down so that it is perfectly flush at your join. [JD]



★ CLOSE A HAIRLINE GAP WITH THIS HAMMER TRICK

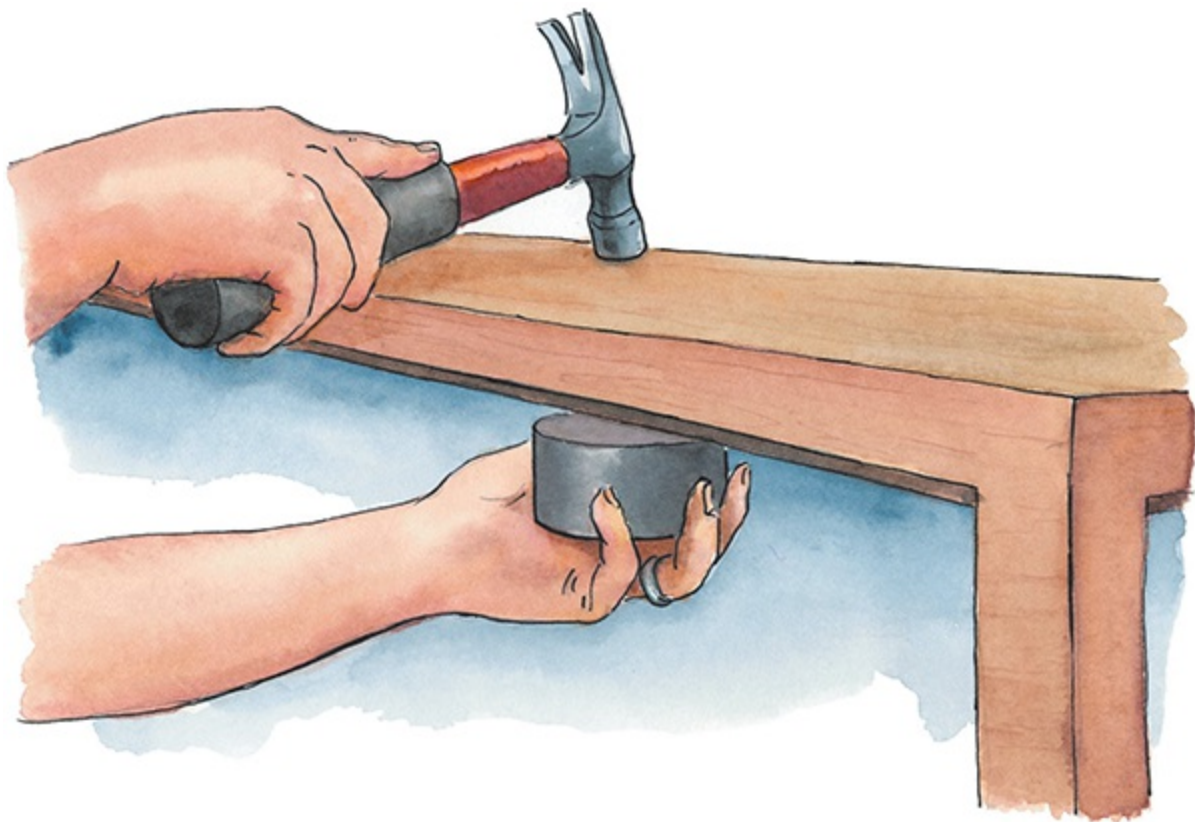
Paul Jackman of Jackman Works shared this tip on his Instagram feed: "A little trick I learned back in 'Nam! Need help

pulling a miter closed when there is a hairline gap left? The curved part behind the head of your hammer is perfect to push that joint shut. Hit it with sandpaper, and you have a nice softened corner.” [PJ]



★ IMPROVISING A SHOP COUNTERWEIGHT

We've previously pointed out Jimmy DiResta's frequent use of chunks of metal and other shop weights to hold things down, ensure square corners, create stop blocks, and so on. Here, he uses a disc of metal as a counterweight when he has to hammer a nail into a long, thin piece of wood with little support. Holding the disc beneath the hammer's striking point provides this needed support and secures the workpiece for confident hammering. [JD]



🔧 WHEN YOU HAVE A NAIL . . .

Dad: "Son, hand me a wrench."

Son: "What size wrench do you want, Dad?"

Dad: "Doesn't matter, I'm gonna use it as a hammer!"

—JON OXFORD

8

GLUING

The use of glue reaches back to the dawn of human history. One can imagine the exciting moment when early humans recognized the cementing powers of things like tree sap, egg white, and beeswax. From that moment on, we've been dreaming up every kind of adhesive and adhesive application we can think of. Makers should never underestimate the usefulness of glue (with a glue gun, we will join the world!) or the benefits of gluing and fastening.

★ THE 3 CS OF GOOD GLUING

From Dmitri Monk comes this tip, first included in “Eyeglass Frame Repair” in Make:.

CLEANING Surfaces should be clean and dry with a matte texture. The glue needs a solid, clean surface with a little “toothiness” to bond well.

CLAMPING Hold the parts steady while the glue sets, or the bond will be weakened.

CURING Give the glue time to set. Straining the bond before it has fully set will weaken it.

★ BREAKING GLUE WITH CANNED AIR

Canned air allows you to freeze and “break” certain types of glue joints, like those made with hot glue, epoxy, and white glue. You can also use canned air to make hot glue dry faster. Just apply the glue, and then hit it with a quick squirt. **[JD]**

★ USING CYANOACRYLATE GLUE AND BAKING SODA AS GAP FILLER

Cyanoacrylate (CA), aka Super Glue, can be mixed with baking soda (you can also use baking powder) to create a strong material that can be sanded, carved, and used for repair, gap filling, and more. Baby powder also works. [\[DH\]](#)

★ BAKING SODA AS CA GLUE KICKER

You can also use baking soda as a “kicker” to make CA glue set faster. Of course, it adds material to the bond, but in many cases that may not be such a bad thing.

★ GETTING RID OF GLUE STRINGS

If you use a hot glue gun and end up with a lot of unsightly glue strings, you can use a portable hair dryer to zap the strings away. Just be careful not to re-melt your glue deposit or overcook any heat-sensitive parts.

★ DEBONDING HOT GLUE WITH ALCOHOL

You can debond dried hot glue with isopropyl alcohol and cotton swabs.

★ KEEPING SQUEEZE TUBE CAPS LUBRICATED

After using Shoe Goo or contact cement in those toothpaste-type tubes, first wipe the threaded neck after use, and then apply a thin coat of petroleum jelly on the threads only. You'll be able to twist the cap off with ease every time. [\[MG2\]](#)

★ LUBRICATING CA GLUE CAPS

Super Glue caps always end up getting glued on. To prevent this, spray some WD-40 inside the cap and it will never stick.

[JD]

★ SPREADING GLUE WITH A THREADED ROD

To spread glue effectively over a surface, especially a fairly large surface, use a threaded rod as a “serrated” squeegee. First, apply your glue in a zig-zag pattern along the entire surface to be bonded. Then, drag and twirl the length of the rod along the surface to smear out perfect rows of glue. You can also use an old credit card with a zig-zag pattern cut along one edge with pinking shears.

★ USE WAX PAPER WHEN GLUING AROUND METAL

When doing glue-ups using bar clamps, the wood glue can sometimes chemically interact with the metal of the bar and stain your wood black. To prevent this, and to make cleanup easier, place wax paper over the bar clamps beneath the project before clamping. [IS]

★ SALT YOUR GLUE TO PREVENT BOARD TRAVELING

If you're gluing pieces of wood that might move during the gluing and clamping process, sprinkle a very small amount of table salt over the glue. It will create just enough friction to prevent the boards from traveling. You can also help prevent unwanted travel by tacking the pieces being glued in a few strategic places before gluing. [IS]

★ **CONSIDER PREFINISHING**

Prefinishing some projects can be a good idea, because it allows you to finish each component before it's assembled. If you do this, first tape up all of the areas to be joined so that you will get a good wood-to-wood bond during assembly.

★ **SHAVING GLUE AT THE "GEL" STAGE**

There is often debate about the best time to remove excess glue from a glue-up. Some builders wipe it away immediately with a damp cloth, whereas others wait for the glue beads to be completely dry before shaving away the rest with a chisel. One other recommended method is to wait for the glue to gel, about 15-30 minutes, and then shave it off with a very sharp chisel.

★ **CREATE AN IMPROMPTU CLAMPING JIG ON YOUR WORKBENCH**

If you want to glue something and you don't have suitable clamps, fasten two pieces of scrap lumber down to a work surface so that they're parallel and slightly wider than the workpiece to be glued. Place your glued-up project between these wedges. Now, use shims between the wedges. The shims are there to hold the glued workpiece firmly in place. **[IS]**

★ **USING HOT GLUE AS AN IMPROMPTU CLAMP**

If you don't need a high degree of clamping pressure (e.g., when you're using a router), consider hot-gluing the workpiece right onto your bench. By gluing instead of clamping, you have the entire surface of the workpiece free for the router to

travel over. When you're done, it's easy to whack or pry the piece free from your table. [\[JD\]](#)

★ **HOW NOT TO TEST IF HOT GLUE HAS SET**

Never use your finger to check to see if the hot glue has dried. It hasn't.

★ **HEAL THE BURN**

Hot glue can stick to your skin and cause painful burns, and it's nearly impossible to remove until after it solidifies. It's a good idea to keep a bowl of cold water nearby so you can dip your hand in it and cool the glue faster to minimize the burn.

★ **USING CHEAP PAINT STRIPPER AS SOLVENT CEMENT**

Unless your application is critical, cheap, liquid paint stripper from the hardware store (not the gel, paste, or color-changing varieties) is a fine substitute for commercial acrylic solvent cement. Comparing one material safety data sheet (MSDS) to another, we see that each product is about 75 percent dichloromethane (aka, methylene chloride), which is the "active ingredient" that softens the plastic and allows it to weld. Purpose-made acrylic solvent is a bit thinner, evaporates a little faster, and contains trace amounts of acrylic monomer that may result in a slightly stronger bond, but for most practical purposes, these qualities don't justify paying twice as much for it. [\[SMR\]](#)

★ **COMBINING HOT AND PVA GLUES**

If you need the long-term bonding power of say, PVA wood

glue, with the immediate hold of hot glue, you can have the best of both worlds! Apply the wood glue all around the outside of the surface you wish to glue, but leave a place in the center dry. Now, apply hot glue to that area and join the piece. The hot glue will bond immediately, and the PVA glue will dry more slowly, leaving you with a piece that is immediately workable, but still bonded for the long term. **[IS]**

★ **PROTOTYPING WITH HOT GLUE**

Don't forget to think about using hot glue as a prototyping adhesive. You can quickly glue up the test parts for a build. This will make them strong enough to hold together to see if everything works, but weak enough to be taken apart again to make changes and before final assembly.

★ **BOND STICKS OF HOT GLUE AS YOU FEED THEM**

If you're feeding a new stick of glue into most glue guns, and it hasn't been grabbed by the feeder mechanism yet, it will fall out while you're gluing at certain angles. To prevent this, dab a bit of hot glue on the end of the new stick before you feed it in, and join it to the stick currently being fed through the gun.

★ **HOT GLUE AS A SEALANT**

You can use hot glue to form a reasonably strong watertight and airtight seal.

★ **USE HOT GLUE AS AN ELECTRONICS INSULATOR**

Wireheads have known about this trick for a long time. You can

use hot glue to hold wires in headers, insulate wires and components on a PCB, and otherwise encase your electronics in plastic. If you decide you want to remove the glue, a small amount of denatured alcohol along the edges of the glue blob will break its bond.

★ **USE HOT GLUE TO CREATE A MOLD**

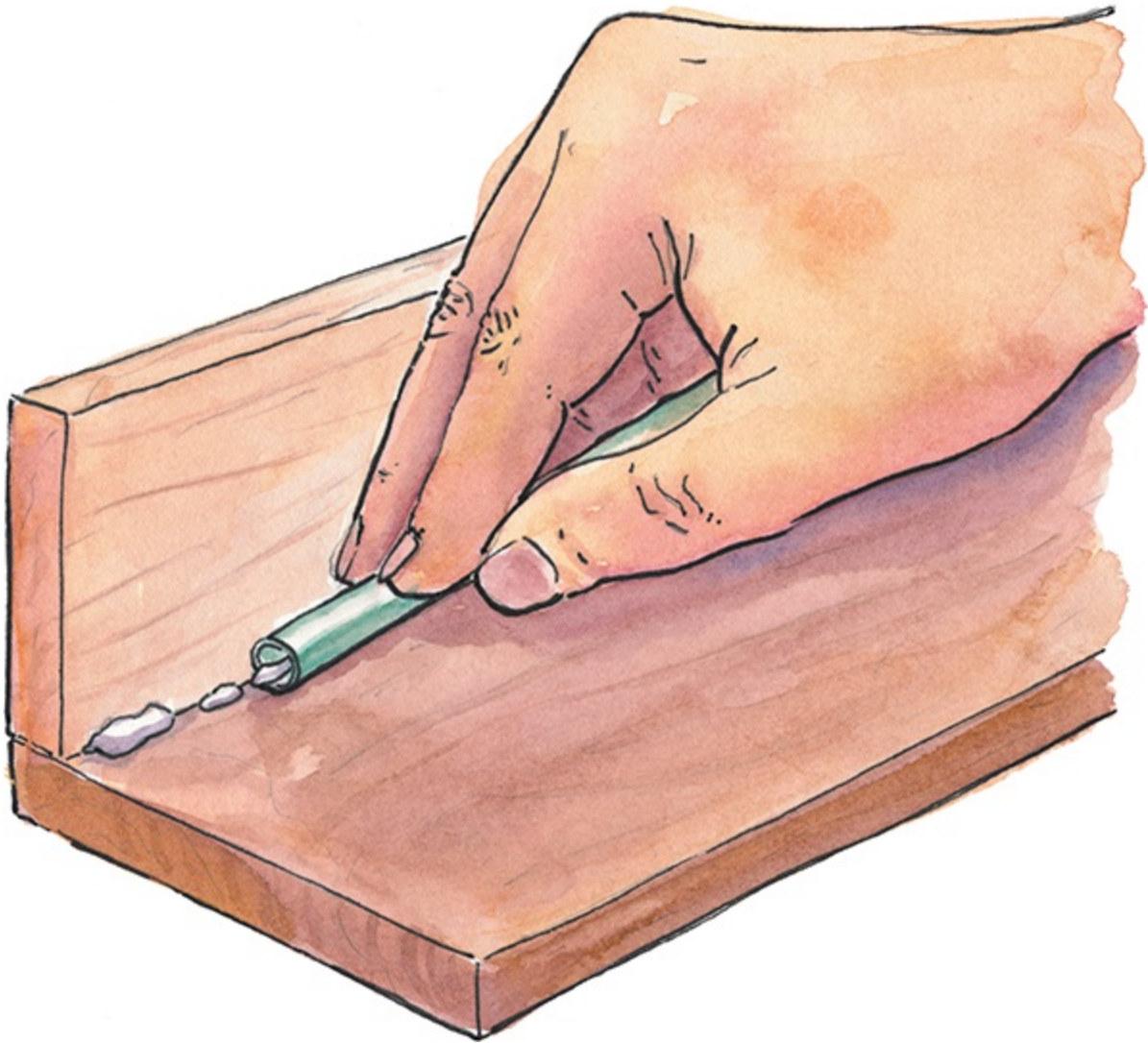
If you want to create a quick and dirty mold for a crude casting of a small part, just lay down a healthy deposit of hot glue, and before it dries, press the object you want to cast into it to create a mold. You can also use hot glue as a casting medium. For instance, silicone ice trays work really well for casting hot melt adhesive.

★ **USE HOT GLUE TO SEAL THE EDGES OF FOAMCORE**

If you're working on a prototype, craft, or modeling project where you want the edges of your foamcore to be sealed, one easy way to do this is with hot glue. First, you have to make a little tool out of scrap foamcore that spans the width of the foamboard you wish to seal. Then, you simply run a bead of glue down the edge of your workpiece and use your tool to scrape off all the excess and ensure a complete seal.

★ **USE A STRAW TO SCOOP UP SQUEEZE-OUT**

There are many techniques for, and much debate over, how to deal with squeeze-out, the excess glue that squishes out from two bonded workpieces. Trying to remove squeeze-out from an inside corner can be especially challenging. This tip from WoodSmithTips shows a clever way of using a plastic drinking straw to scoop up squeeze-out from inside corners.



★ **CREATE A WATER-RESISTANT MIXTURE WITH PVA AND . . . WATER**

You can create a water-resistant solution, for treating things like a fabric shower curtain, by soaking the fabric in a mix of PVA glue and water. PVA is not waterproof, but it will add water resistance. Carpenter's glue is waterproof, so I guess you could mix that with water for true waterproofing? [\[AL\]](#)

★ **NEEDLE BOTTLES AND CAPILLARY ACTION**

You can buy 10-packs of 30 ml, needle-tip glue bottles online for under US\$10. If you put your CA glue in one bottle and the CA accelerator (aka a “kicker”) in another, you can use capillary action and a kicker to very quickly glue up plastic, wood, and other materials. You simply hold or clamp your pieces together, run a bead of glue along the joining edge, followed by a swipe of the kicker—done. If you watch YouTube videos of seasoned plastic scale model builders, you’ll see most of them very quickly assembling a model using a needle-tip bottle, a kicker, and capillary action.

9

DRILLING

I was at Maker Faire Bay Area in 2017, sitting at the hotel bar where all of the staff and makers stay, trying to charm my way to free drinks and a few free tips for this book. I had just bonded with friend and toy inventor extraordinaire Bob Knetzger over our mutual love of Jack Daniels and we were sipping some Gentleman Jack that he had just ordered. I asked him if he had any tips for the book and he responded: “Close your eyes before blowing the dust out of drilled holes.” I laughed, thinking he was joking. It seemed like a tip so obvious it wasn’t even worth mentioning. But when you think of it, this is just the kind of thing you could easily forget (and why you should always wear safety glasses when working on projects where anything can threaten your precious peepers). As I thought more about it, I decided this was one worth sharing. “Great one, Bob. Thank you. You rock,” as I wrote it in my notebook. “Would you like another Jack?” he asked. “Sure,” I enthused, suddenly wondering how many tips I was going to manage to collect before tips turned to tipsy.

★ **TAPE YOUR BIT TO MARK DRILL DEPTH**

To drill to a precise depth, measure that depth on the bit, and wrap a piece of masking or brightly colored tape there. Then, drill to the bottom edge of the tape. You can also mark the depth directly onto the bit with a Sharpie. **[JD]**

★ **ADD A WOODEN DRILLING GUIDE TO YOUR**

DRILL

Create an easy jig for drilling perfectly straight holes by attaching a small piece of wood to your hand drill (on the top or on one side) and place that against a flat surface, perpendicular to where you want to drill your hole. When attaching the wood, make sure it's perfectly parallel with the bit. [JD]

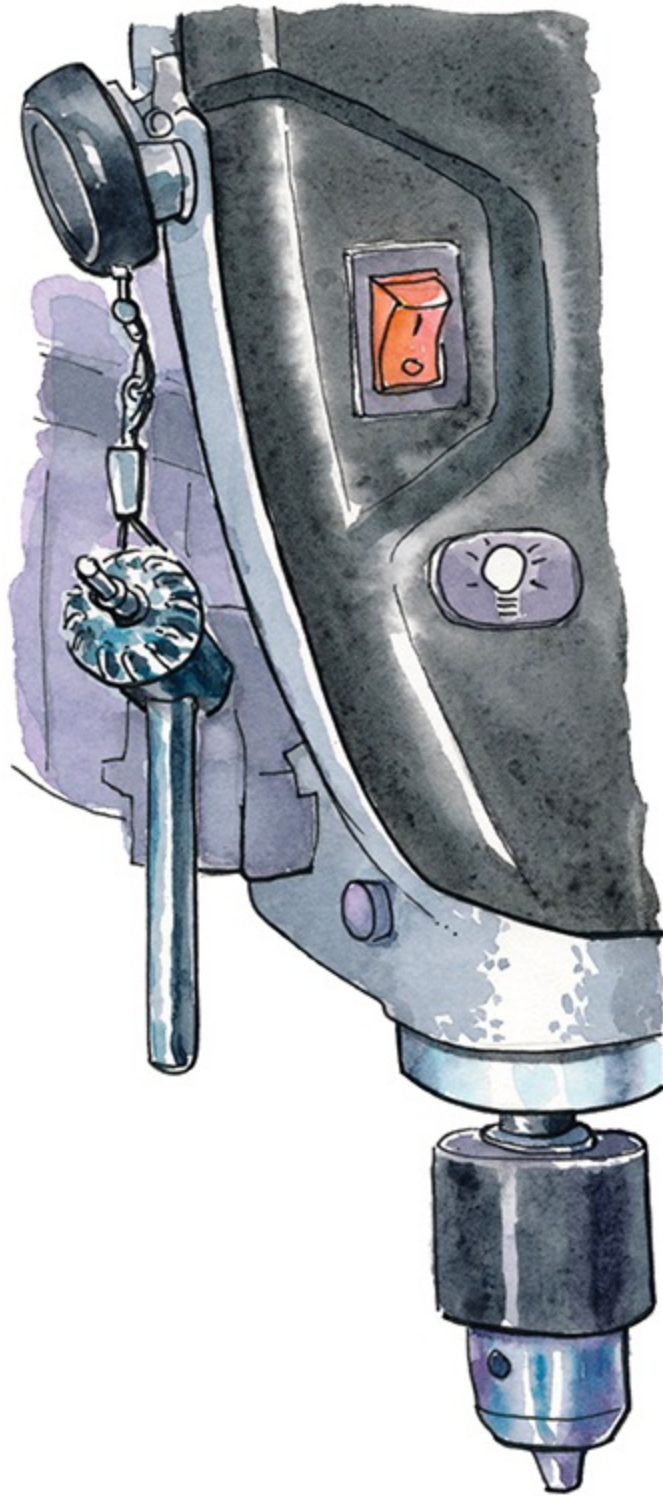
★ TAPE A LEVEL TO YOUR DRILL

To make sure you're drilling a hole perfectly straight, tape a small level onto the top of your drill. You can remove it when you're done. [MC]



★ **SAVE YOUR DRILL PRESS CHUCK ON A KEY RING**

Tired of losing the chuck on your drill press? Use a retractable magnetic keyring to store it close at hand by mounting it on the press itself. [\[SMR\]](#)



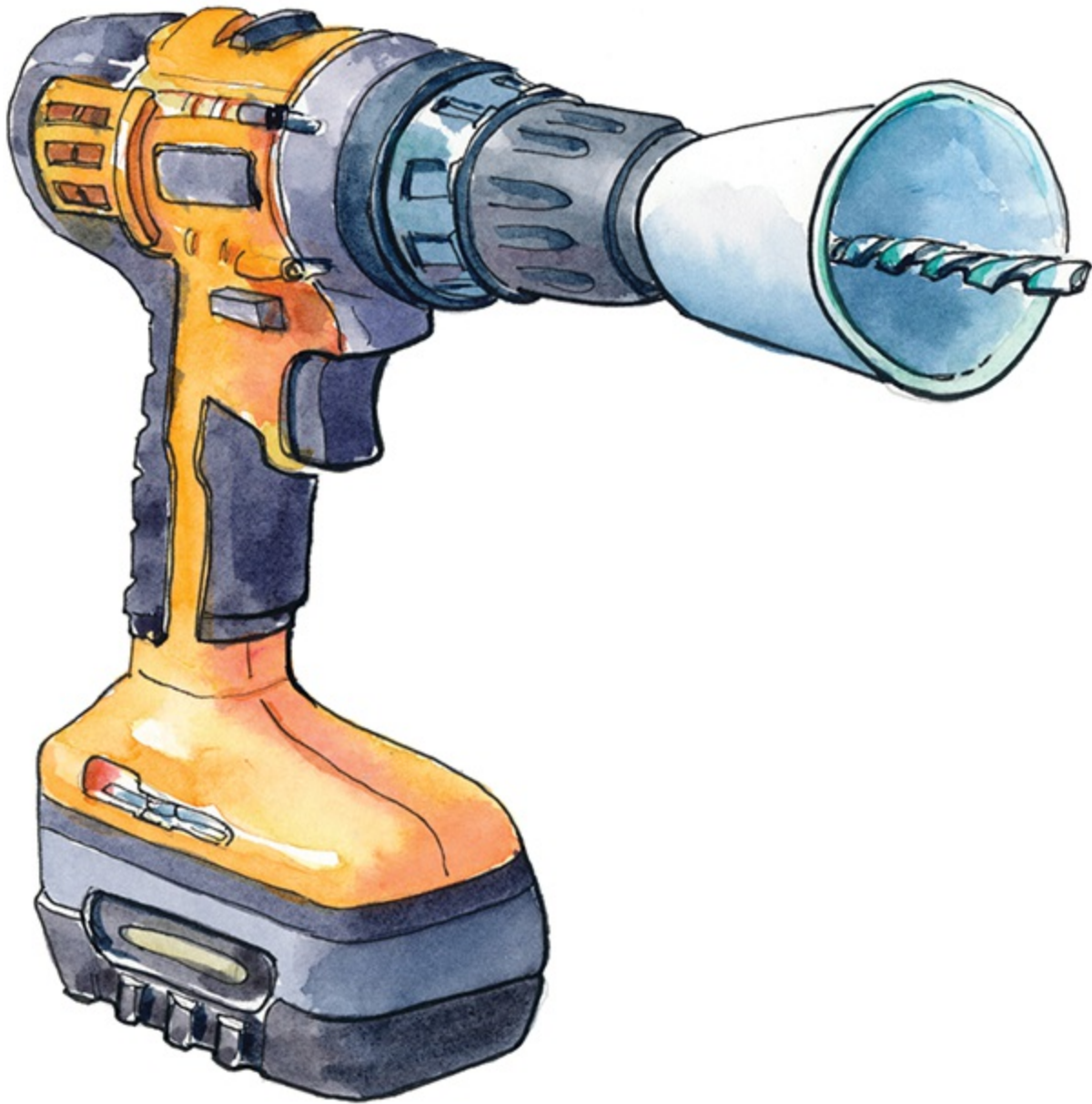
★ **CATCH DRILL DUST WITH A COFFEE FILTER OR POST-IT**

If you are drilling a hole in a wall and don't want the sheetrock dust everywhere, use painter's tape to attach a coffee filter below where you're drilling to catch all of the dust. You can also fold a Post-it Note and stick it underneath where you're drilling to do the same thing.



★ **CATCH DRILL DUST IN A COFFEE CUP**

Drilling a hole in the ceiling? Feed the drill bit through a paper coffee cup and let the cup catch the dust. You can also cut the bottom off a two-liter soda bottle and use that.



★ **MAKE A SIMPLE JIG FOR DRILLING STRAIGHT HOLES**

One method of drilling a straight hole without a drill press is to create a drilling jig by either cutting a 90-degree notch from a scrap piece of lumber, or offsetting two smaller pieces to create a 90-degree corner. Place your drill bit in the crevice of that 90-degree angle and drill. You'll end up with a near-

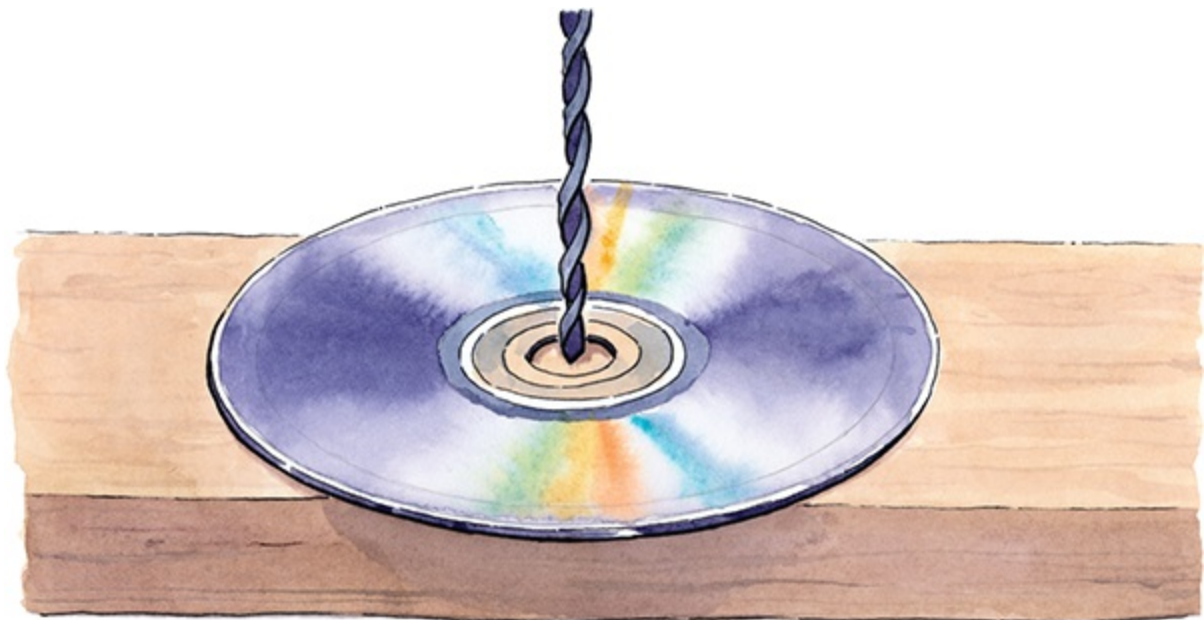
perfect hole, perpendicular to your lumber. **[Is]**

★ **USE A NAIL AS A PILOT HOLE BIT**

If you need to sink a pilot hole for a screw, and you don't have the right size bit, or you don't want your nail to split your board, you can use the nail as the bit to create a predrilled pilot hole. Simply snip the head off the nail, chuck it into your drill, and drill as if it were a normal bit.

★ **USE A CD TO HELP YOU MAKE A STRAIGHT HOLE**

Lay down any old Clay Aiken CD (or equivalent) reflective side up. Position the drill bit in the center hole and line it up with its own reflection in the CD for a 90-degree angle.



★ **PUNCH BEFORE YOU DRILL**

To keep your drill bit from roaming around when you're drilling, always cross measure and use a center punch to make a

dimple in the wood. It will act as a guide to get the bit started.

★ **WATER-COOLING ACRYLIC DRILLING**

If you've done any cutting or drilling into acrylic material, you know that, as the saw or bit gets hot from the cutting friction, it begins to melt the plastic. You can help prevent this by lubricating the hole with water, similar to the way you would use oil in metal cutting. The water will act as a coolant and prevent the plastic from melting. **[BK]**

THE CASE OF THE RATTLING AWL

The first car I remember my parents owning was a 1977 Chevrolet station wagon—blue, with fake wood paneling on the sides. A few months after buying the car, something within the passenger-side rear compartment wall, near where the spare tire was stowed, began to rattle. Soon, the noise irritated my father enough that he disassembled the interior paneling to find and silence it.



That is where he discovered the tool, a hand awl, presumably lost or abandoned there by an upholstery installer on the assembly line. Dad, who has never been a big fan of organized labor, at least once advocated the latter theory—that the awl was abandoned in the car, on purpose, by a worker exploiting union regulations that he or she could not be required to work unless provided with the correct tool. Being considerably more liberal, I am prepared to give that long-ago member of the United Automobile Workers union the benefit of the doubt and believe it was left there by accident.

Dad put the awl in the top drawer of his toolbox and it's lived there ever since, though the car it came in is now 30 years gone. It's heavy, solid, and quite well made, with a turned aluminum handle and replaceable pommel- and tip-fittings. I use it fairly often, and every time I do, I wonder about the worker who walled it up so many years ago, and about how the world has turned since then.

—SEAN RAGAN

10

FASTENING

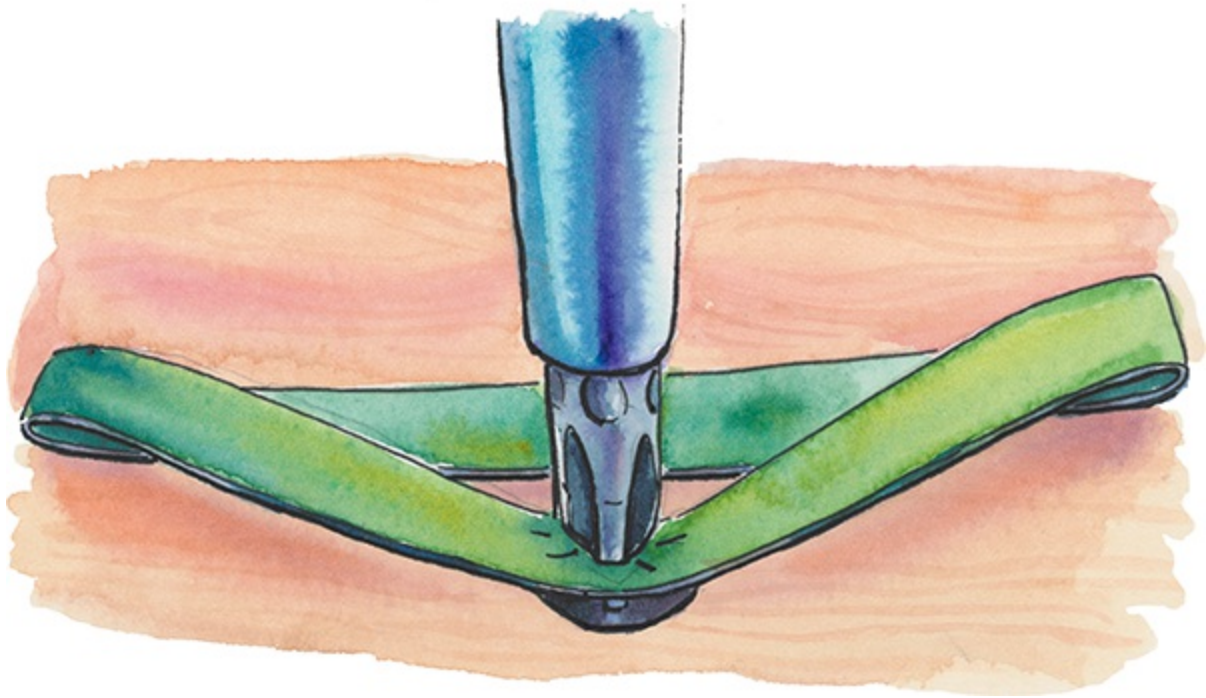
In the Introduction, I tell how listening to the stories people told as they shared their tips inspired this book.

There were two specific tips, though, that also inspired me to write this book. The first was a trick I saw for removing a broken lightbulb from a socket—a sticky (and potentially bloody) situation, right? You simply cut a potato in half, jam the slice o’ spud onto the broken bulb fragment in the socket, and then twist it out. I got the biggest charge from seeing that. It’s so smart, so simple, and the kind of clever hack that’s as much of a brain-treat flavored with human ingenuity as it is a worthy solution to a problem. A few days later, I had a similar inspired moment when I saw the first tip in this chapter about using a rubber band to help remove a stripped screw head. Seeing these two tips within a short span of time had a weird effect on me. It may sound corny, but tips like this that are such a simple and seemingly perfect solution to a problem have a lingering impact on me. I start seeing my world in a slightly different way; I start working in a slightly different way. This gave me the idea of putting together a collection of such insightful tips in the hope that, in looking through them, not only would the readers find dozens of ideas to improve their making activities, but it might also have the effect of inspiring people to see and think in a slightly different way. So, without further ado, here’s one of the tips that started it all, along with a dozen or so additional eye-opening ideas related to the fine art of fastening things together.

★ USING A RUBBER BAND ON A STRIPPED

SCREW

Got a screw with a stripped head? Place a wide rubber band over the head and unscrew as normal.



TOP 5 USES FOR POSTER PUTTY

Most of you are likely familiar with poster putty (Blu Tack, Fun-Tak, Duck Putty—it goes by dozens of different brand names). It is a non-drying, low-tack mounting putty that was originally designed to hold posters onto walls. But there is so much else you can do with it. Because it's cheap, reusable, low-tack, leaves little-to-no residue, and much more, it is perfect for all sorts of diverse applications. Certain hobby communities, such as scale-modelers and tabletop gamers, long ago made poster putty a staple of their toolboxes. Here are 5 of the best, unexpected uses for poster putty:

1. IN PLACE OF HELPING HANDS

One of the great uses for poster putty is to hold small objects while you work on them. You can stick parts that you are gluing together, painting, or

similar, into a blob of it. You can use it as an impromptu tool, parts holder, or pin cushion. You can also use it in place of conventional helping hands when you're assembling electronics. You can press PCBs right down on it and it won't usually leave any visible residue. You'll obviously want to clean your board afterward, but you would do that anyway. Once you start to incorporate the use of this material into your electronics bench workflow, you'll likely find yourself grabbing it instead of helping hands in many situations.

2. AS A MASK

Poster putty is widely used in modeling applications as a mask. You can use it as quick and dirty masking material for airbrushing and other painting (say, to cover an airplane cockpit canopy before painting) and in creating pretty effective, organic-looking camouflage patterns on models. You can also use it to cover areas that will be accepting glue later on so that you're not gluing painted parts together. Tabletop Minions has a brief introduction video on YouTube on using poster putty in model-making.

3. AS A PROTOTYPING OR TEST-FITTING TOOL

Poster putty can be extremely useful when you want to test-fit or test-assemble almost anything, from plastic models to wooden furniture. You can do all of the joining with poster putty, make sure everything is how you want it, and then permanently glue it. Modelers use poster putty all the time for this purpose.

4. AS A SCREW HOLDER

If you are in a situation where you can't hold a screw with one hand and a driver with the other, just put a little blob of poster putty on the head of the screw and let it hold the screw on the tip of the driver while you drive it home.

5. AS A VIBRATION STABILIZER

Even if you don't use poster putty to hang a picture, you can still use it to hold the bottom corners of the frame in place so that vibration doesn't

make it crooked. This type of adhesive is also known as museum putty because it can also be used to secure objects on a shelf so that vibration doesn't knock them off. I image that poster putter is especially popular for this application in earthquake zones.

★ **HOLD A SCREW IN PLACE WITH PAPER, A COMB, OR A PENCIL ERASER**

If you're trying to get a small screw or bolt into place, but can't quite grip it, just poke it through a scrap of paper and use the paper to hold it while you start to screw. Once the threads have taken, rip the paper away. You can also use a comb and place a small nail or brad between two teeth. And for holding small brads that can be too small to hold confidently in your hand, you can use a pencil eraser. Just poke the brad through the eraser, hold the pencil to position the brad, and then begin hammering. With the brad embedded in the workpiece, you can tear away the eraser and finish sinking your nail.

★ **TWIST OFF THAT ZIP TIE TAIL**

When trimming down the excess tail on a zip tie, don't cut it. This will leave a sharp-edged tail that can scratch you. Use pliers or a multitool to twist the excess off, flush with where the lock is. This will sheer off the excess fairly cleanly and leave no scratchy tail. [\[SH\]](#)

★ **LUBE A SCREW WITH BAR SOAP**

This is a boatbuilder's trick. If you lubricate a screw with soap, it goes in a lot easier and holds just as well. [\[TA\]](#)

★ **USE YOUR PENCIL AS LUBRICANT**

If you're in the field and need a lubricant, say to re-pin the hinge on a door, don't forget that graphite (pencil lead) makes an excellent lubricant in a pinch.

A PIVOTAL POINT IN HISTORY

Recently, I've been learning how to repair antique clocks under the guidance of clock expert Bob Frishman. When assembling a clock, there are many axles with pivots on the end that must be fitted within the holes in the clock's plates. It is one of those jobs that seems to require 10 hands. A pivot locator is a long, thin tool used to gently nudge the pivots into place. You can buy them, but I've come to love the one shown here. It's handmade, but not by me.



I live in Lowell, Massachusetts, which was once a major producer of textiles. Mill workers would fashion tools for themselves to help them do their particular jobs. I found one such tool at a local antique shop and bought it. I stopped by the Boott Cotton Mills Museum at the Lowell

National Historical Park to ask exhibit specialist Rick Randall about the tool. He told me that the tool is called a reed hook or weaver's hook. It was used to catch the end of a piece of yarn so that it could be threaded through the appropriate parts of a machine. Along with a pair of scissors, every loom operator had one tucked into her apron, as seen in this image of a Massachusetts mill girl from 1916.



The weaver's hook had a simple U-shaped bend at the end when I got it. The handle is made up of a stack of thick leather washers, which were shaped, then tacked together at the base. A tarnished brass ferrule caps the front end of the handle. Copying the design of a commercially available pivot locator, I bent a second curve in the end of the tool, forming an S shape. This shape allows me to push or pull a pivot, as needed, when the pivot is out of reach. It has the advantage of being longer than many of the store-bought versions. The square-sided handle prevents the tool from rolling off the workbench and helps me keep it oriented properly when in use. The tapered metal shaft provides feedback that reminds me not to use excessive force, which can cause the delicate pivots to bend.

I like the idea of using an antique tool to repair an antique clock. Every time I reach for it, I wonder about the mill worker who once used it. What was

her name? What was life like for her? I'll never know all of the answers, but it's reasonable to assume she spent many 10- to 14-hour days working with this tool. Surely, it would have felt like an extension of her own hand. For me, the tool is a tangible connection to the history of the city and the people who once lived and worked in it.

—DUG NORTH

★ **TAPING SLOTTED DRIVERS FOR DELICATE SCREWS**

If you've ever worked with brass screws, especially antique ones, you know that their heads can be soft and have a tendency to strip. You can help minimize the chance of this happening, and keep your screws unmarred, by wrapping a slotted driver with masking tape before working the screws.

[JEP]

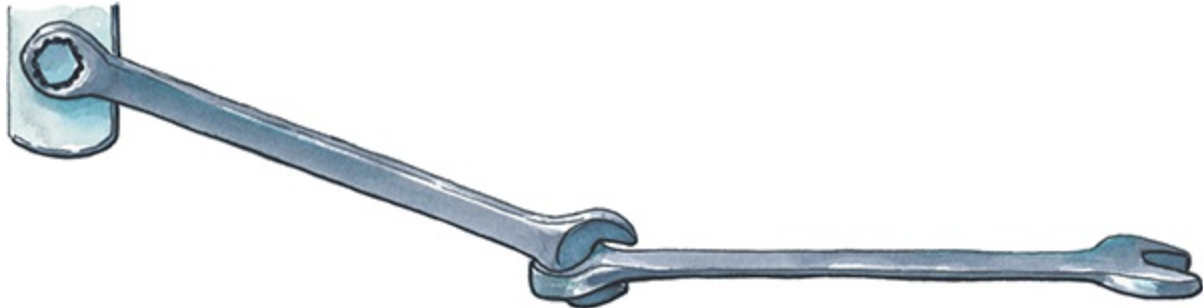
★ **TURNING WOOD SCREWS COUNTERCLOCKWISE TO START THEM**

Make: contributor and toy designer Bob Knetzger, writes: "In order to avoid cross threading or stripping out wood screws that you're going to remove and then screw back in, don't just start turning the screw. Place it into the existing hole, but first turn it backward (counterclockwise), very sensitively, with just a tiny bit of inward pressure. At some point, you'll feel the screw fall into the previous thread in the wood. Stop! Now turn the screw clockwise to tighten. This will prevent you from stripping out the wood!" [BK]

★ **CHEATING A WRENCH**

On the Classic Work YouTube channel, Ethan shows off some

“mechanicin” tips, including this leveraging classic known as “cheating a wrench.” Basically, you interlock one C-wrench with another to gain a much greater mechanical advantage. As he points out, you have to be careful to keep everything square or the wrenches could slip and you could break your wrist. If it’s carefully done, though, you’ll be amazed at how much pressure you can bring to bear.



★ **REDUCING NAIL GUN PRESSURE ON THE FLY**

Andy Birkey shares this fantastic nail gun tip that he says is commonly used in production shops. Sometimes, such as when you’re driving nails into very thin stock, the gun’s strong air pressure can drive the nail clean through the board. The normal thing to do would be to reset the PSI on your air compressor. But instead of having to walk to the compressor to adjust the pressure, you can simply angle the head of the gun to the side a little in order to dissipate some of the momentum with which the nail is driven into the workpiece. **[AB]**

11

GENERAL ELECTRONICS

When you first get into electronics and start putting together kits, those kits usually come with a components checklist, and each step in the build process is designed to be checked off as you progress through the project instructions. You are always highly encouraged to inventory all of the parts in the kit before you start and to mark off each step once completed. This is a great habit to retain. A lot of the perceived complexity of electronics work is thanks to lots of tiny little parts to keep track of, and dozens (and dozens) of solder points to lay down onto a tiny and over-populated printed circuit board (PCB). By just being careful, methodical, and organized, you alleviate a lot of the problem. Taking the time to set up a PCB project, inventorying and sorting the parts into temporary parts containers, reading through all of the instructions, and blocking out the build in your head will all pay off in the end. Let's take a look at some other tips for working with PCBs, electronic components, and general electronics.

★ **SORTING PARTS ON A STICKY MAT**

Sean Ragan offers this great tip. If you are doing a teardown, or working on an electronics project with a lot of small parts, consider getting a dashboard sticky mat. You can get them online for around US\$10. They will keep all of your parts in place and well organized until you are ready to use or sort them. **[SMR]**

★ CUTTING PCB FIBERGLASS

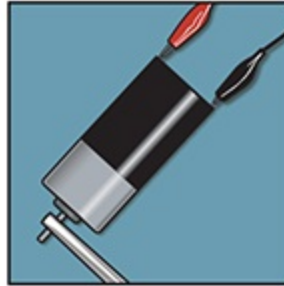
If you need to physically cut fiberglass (FR4) circuit boards, avoid using saws or rotary tools. The fiberglass is very hard on your tools and produces hazardous dust. A shear is the right tool for the job. Heavy-duty tin snips or bolt cutters can be used with relative ease and precision. [WO]

Tricks of the Trade

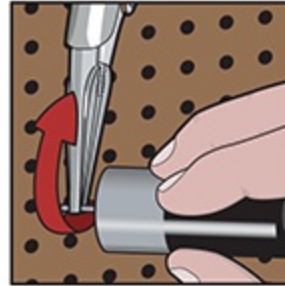
Tim Lillis (narwhalcreative.com)



Have a bunch of motors in your shop but don't know their voltage ratings? Use this trick from Mark W. Tilden via Dave Hrynkiw at solarbotics.com to get organized.



First, attach a pair of vise-grip pliers to the output shaft. Then hook the motor terminals up to a voltmeter.



Holding the motor, spin the output shaft reasonably fast until you feel a decent load. (Not too hard—don't break it!)



As you spin the motor, you'll see the approximate voltage range intended for that motor! This trick works best with gearmotors.

📦 TIPS FOR BUYING ELECTRONIC COMPONENTS ON EBAY

Having a stock of electronic components can greatly increase productivity and your enjoyment of electronics. Since hobby projects and prototype projects are often incremental in nature, it is great to be able to grab a part from your bin and just keep working, rather than having to order parts and wait for delivery.

It is a good idea to gradually build up an inventory of parts that you use most, and one way is to always order extras when you order parts for a project. Extra parts are helpful if you, say, burn out chips while prototyping, and you can build copies of your project without having to wait for a new set of parts. You can also get quantity discounts, which reduces the cost of your projects.

GENERAL EBAY BIDDING TIPS

Use a sniping program or service to enter your max bid in the last few seconds of an auction.

This prevents casual bidders from seeing your bid and raising theirs throughout the auction. However, this won't help much with professional bidders, since they pick a price and stick to it. Look at similar auctions to see when the bids come in relative to the auction's end to see whether other bidders are sniping also. This will also help you to stick to your plan and not get caught up in the excitement. Last, but not least, it keeps you from needing to check on the auction obsessively at inconvenient times!

When bidding on a sequence of auctions for similar items, bid hard on the first item up.

It will often go for the lowest price because other people are waiting to see what the ending bid will be. Also, when there are larger (but finite) number of items, prices will sag in the middle and go up again toward the end as people realize their chances for winning the item are running out.

Avoid the Big Gulp Syndrome.

It can be very tempting to buy thousands of parts for one-hundredth of retail when you only need a few—but exercise caution. For hobby use, be careful of Big Gulp Syndrome: even if the unit cost is much lower, what matters is the total cost for the number you need (and a few extras). You don't come out ahead if you buy a hundred times what you needed, and then you have to store all of the extra parts somewhere.

There may be situations where you do need a lot of parts and can find the exact ones super cheap on eBay. But in general, this is not a great way for hobbyists to build up stock, and probably not a good way to save money on parts for small-batch production.

EBAY ELECTRONICS BUYING TIPS

You shouldn't really believe specs on LEDs like brightness, color properties, or lifetime provided by foreign vendors.

These vendors don't have resources to verify specs, so they wind up copying from other vendors. You should also buy some and test them first

before using them in a project. Lastly, if lifetime matters, buy from a name-brand company with the resources to test their claims.

When buying something like white or RGB LED modules that have color variations, buy all that you need for your project (plus extras for defects) in one batch from one vendor.

This reduces lot-to-lot color variations that can be visible when everything is lit up together.

When buying modules on a deadline, it is wise to order from multiple vendors.

Also, have a backup plan in case there are shipping delays or what you get doesn't work or isn't what you expected.

Before buying an item, search again using the keywords in the description to see prices from other vendors.

Frequently, several vendors will sell the exact same item (with the same photos even), but at different prices. Sometimes, one vendor will have different pricing for the same part at different times. If you need a small quantity, look for auctions with starting bids below Buy It Now prices. You will often be the only bidder and save money. Don't get into a bidding war, though! Be patient and wait for an auction with no bids.

MISCELLANEOUS AUCTION BUYING NOTES

- It is unusual to see the latest popular microcontrollers, LED drivers, or hobbyist favorites, such as 555 timers.
- If they do appear, prices get bid up close to distributor levels. The savings will be minimal, so don't bid unless you have a current need.
- Popular chips can be in unpopular or obsolete packages.
- Leaded components are often sold on reels for automated manufacturing, which can take up a lot more space in a hobbyist's closet than bags of bulk components.

★ **USE MAGNIFICATION**

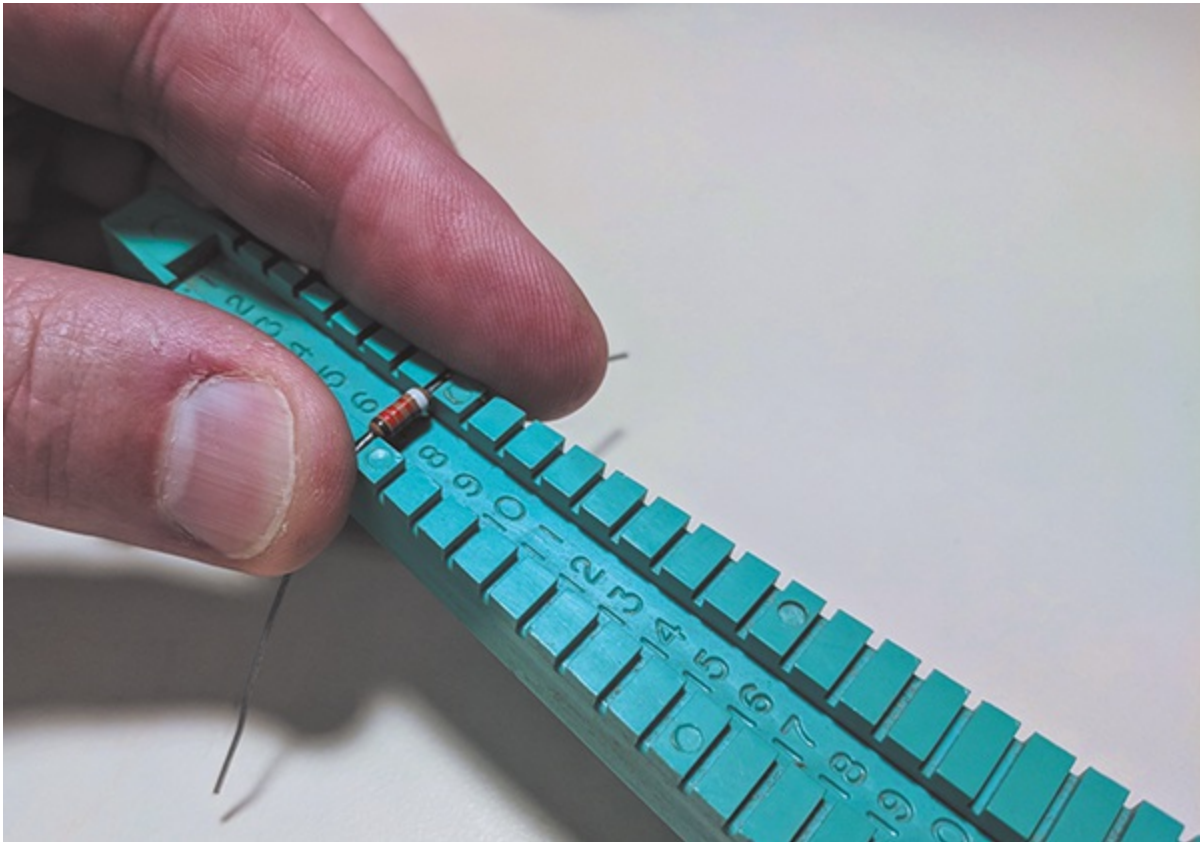
For successful PCB work, especially troubleshooting soldering issues like cold joins and solder bridges, you will need some form of magnification. Always have a glass, jeweler's loupe, or magnifying visor on hand to inspect your work as you go. You can also get full-spectrum fluorescent swing-arm lights that have a magnifying lens on them for fairly cheap. These can be helpful, especially if you're new to soldering and really need to see what you are doing.



★ **GET A COMPONENT LEAD TOOL**

Component lead-bending tools, often branded by a supplier

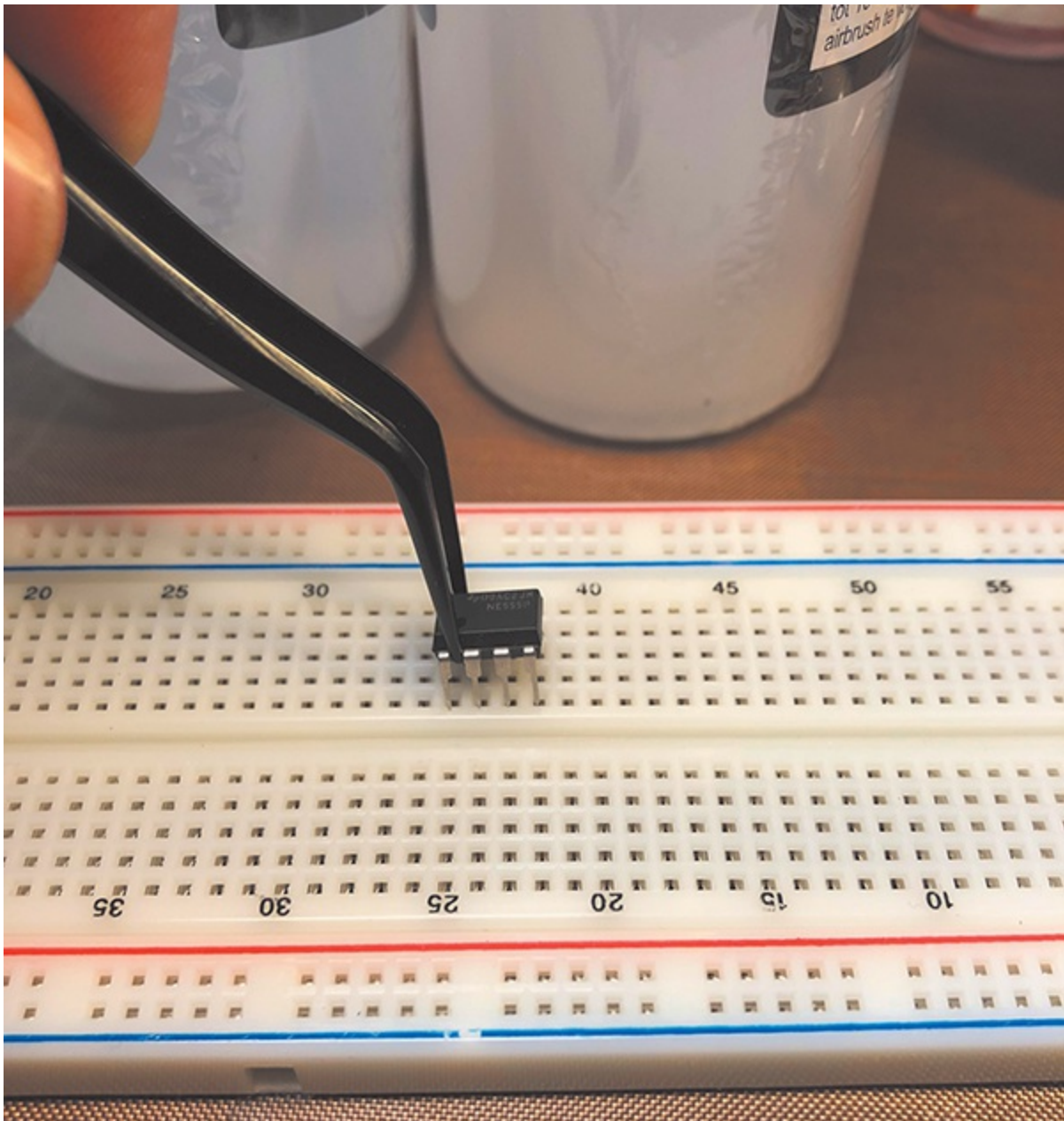
and given away as swag, are a great little addition to your electronics toolbox. Along with pre-planning and organizing, having the discipline to keep your circuits neat, tidy, and tight to the board will pay off in the end. Precisely bending component leads to the proper lead width can help in that process. The bending tool in this picture belongs to Steven Roberts, aka The High-Tech Nomad. I love how you can see that it is a well-used tool.



Our pals at Evil Mad Scientist Labs (evilmadscientist.com) sell a bending tool for resistors. One side of it is designed for $\frac{1}{4}$ W resistors (sizes 0.4"–1.5"), the other for $\frac{1}{2}$ W resistors (sizes 0.5"–1.5"). It works for $\frac{1}{8}$ W resistors as well. This is one of those tools that is likely to get a, "How have I lived without this?" response after you've had a chance to use it.

★ **USE A PAIR OF TWEEZERS**

Get yourself a pair of electronics tweezers. Even if you're not mainly working with surface-mount components, which are tiny enough to require such tweezers, adding through-hole components to the board is much easier with tweezers than trying to get parts in place with your fat and meaty end-effectors.



★ **ALWAYS GIVE YOUR BOARDS A BATH**

When you first get into electronics, it seems counterintuitive to expose your circuits to cleaning solutions, but cleaning your PCBs should always be part of your circuit-building regimen. And you want to clean the board before and after you populate it. Make: contributor Ross Hershberger writes, "Cleanliness is next to solderliness. Freshly scrubbed copper takes solder with less heat and wets more thoroughly, so always scrub or otherwise de-oxidize your boards before soldering. I use isopropyl alcohol and a fine abrasive like a Scotch Brite. You can also use a pen eraser followed by alcohol. For bad corrosion, use a glass fiber 'pen.' Steel wool may leave fibers that can cause shorts." [RH]

	Effectiveness	Cost
Brush/Alcohol	Yellow	Green
Brush/Flux Remover	Yellow	Yellow
Ultrasonic cleaner	Green	Red

Green = Good, Yellow = OK, Red = Not So Good

★ USING BLACK HOT GLUE AS A LIGHT SEALANT

Hot glue sticks comes in a number of colors, and at least one of those colors has a practical use. Black glue sticks can be used in electronics to act as a light sealant. In some electronics projects, you might want to seal up or block light-emitting components so that you don't get photonic noise or crosstalk. Black hot glue is just the ticket. **[BK]**

12

SOLDERING

At Make:, we're fond of telling people that there are two fundamental skills that all makers should know: soldering and sewing. Lots of people seem intimidated by soldering, but they shouldn't be. If you have a halfway decent iron, a clean and hot tip, and spend a little time practicing on some junk electronics, you can be a serviceable solderer in no time. The following tips can also go a long way toward making soldering easier.

Years ago at Maker Faire Bay Area, we started doing "Learn to Solder" workshops, where Faire-goers pay a few bucks for a soldering kit, usually a simple blinking LED circuit on a cool circuit board. There is a great tip found in this kit and in this workshop for all who teach beginner electronics (or really who teach anything hands-on). The kit is just challenging enough that people who attend the basic soldering introduction and then build the kit feel like they've really accomplished something—that's the level you should be aiming for.

During the year where we held the first soldering workshop, I was in the Maker Shed tent talking to Dave of Solarbotics. A dad and his daughter came up and Dave started giving them the sales pitch to a very simple robot kit that they had just released: "And, it doesn't require any soldering." The little girl scrunched up her nose and shook her head in disinterest. "But I already know how to solder," she said, pointing proudly to the blinking Makey the Robot pin she had just put together. "I want a project with soldering."

So, learn to solder, check out the following tips and, like that

little girl, you'll soon be turning your nose up at those lame "no soldering required" kits.

LET'S DO THE SOLDERO DANCE!

Like many good things in life, good soldering is all about timing—rhythm. It's a sort of dance where you have to get the sequence and the timing just right. And, like dancing, as you learn, you will go from feeling like a fumbling klutz to joyfully finding your groove. And then, the real fun and self-expression can start. There's nothing like having a lot of components to solder on a PCB, getting on a roll, and seeing these near-perfect little solder beads being laid down in quick succession, like you're some kind of precision solderbot. You'll know you've finally become good at soldering when you look at that empty PCB and a big pile o' parts and feel excited to get crankin', rather than feeling like you're about to tackle your tax returns.

To emphasize the sequence and timing aspects of soldering, we've illustrated it as a little dance. Follow along with us, won't you? 1-2-3, 1-2-3 . .

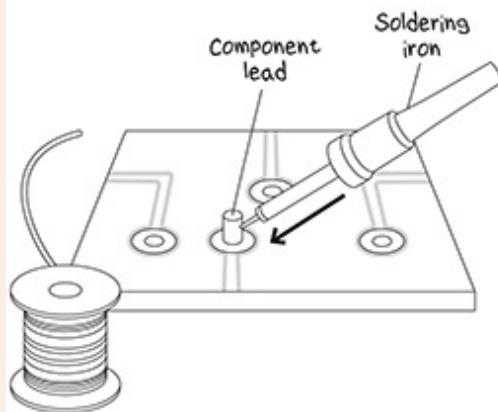
Step 1

The first step in our fire-stick and molten-alloy rumba (after you clean your iron on the moist cleaning sponge on your stand) involves touching the hot iron to both the component lead that you've poked up through the PCB and the copper solder pad. You want to heat both of these elements, as they need to both accept the solder.

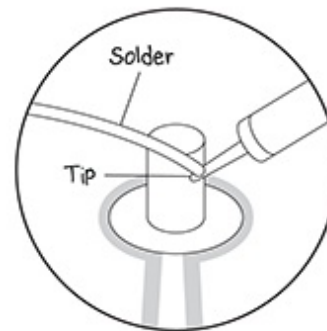
The Side Step

A little side-step trick, after heating the pad and component lead, is to touch the tip of the solder wire to the tip of the iron to sort of get it in the mood for melting. Just a quick touch to the iron is all you need.

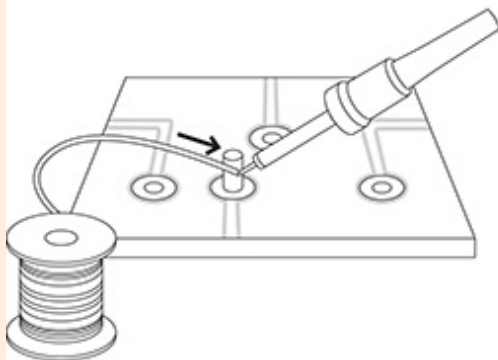
Step 1: Hold, Hold...



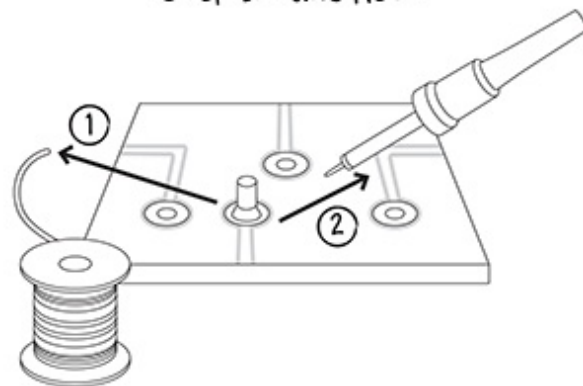
Side Step: Double Time



Step 2: Hold, Hold, Melt!



Step 3: ...and Rest.



Step 2

Now touch the pre-heated tip of the solder to the other side of the component lead (farthest away from the iron). Now you have the solder, then the component lead in the middle, and then the iron on the other side. It should take only a few seconds for the solder to flow. It's very important that the iron is clean and hot and that you're heating both the pad and the lead at the same time.

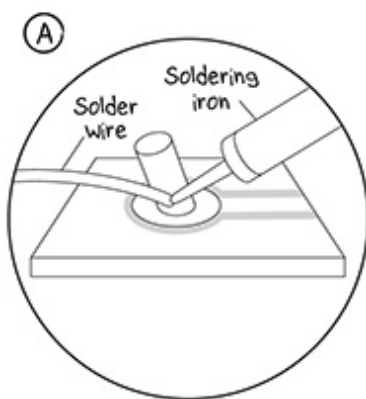
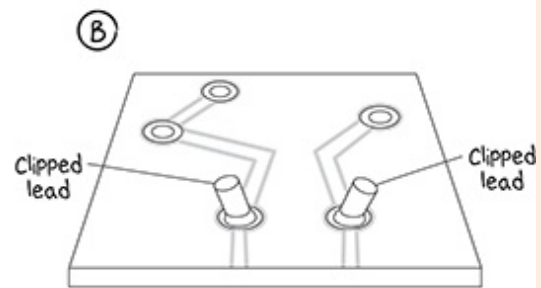
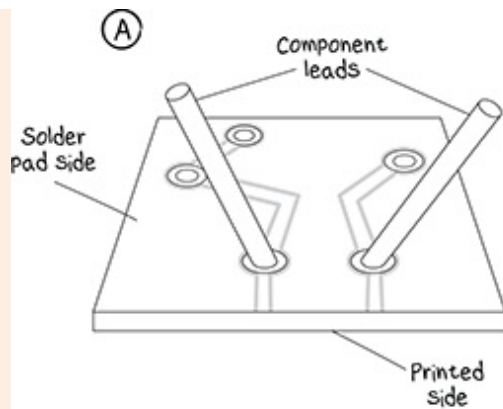
Step 3

As soon as the solder flows and you have a nice plump little mound of solder, pull away the solder wire first and then the iron. If you pull the iron away first, the solder will instantly cool and stick the solder wire to your

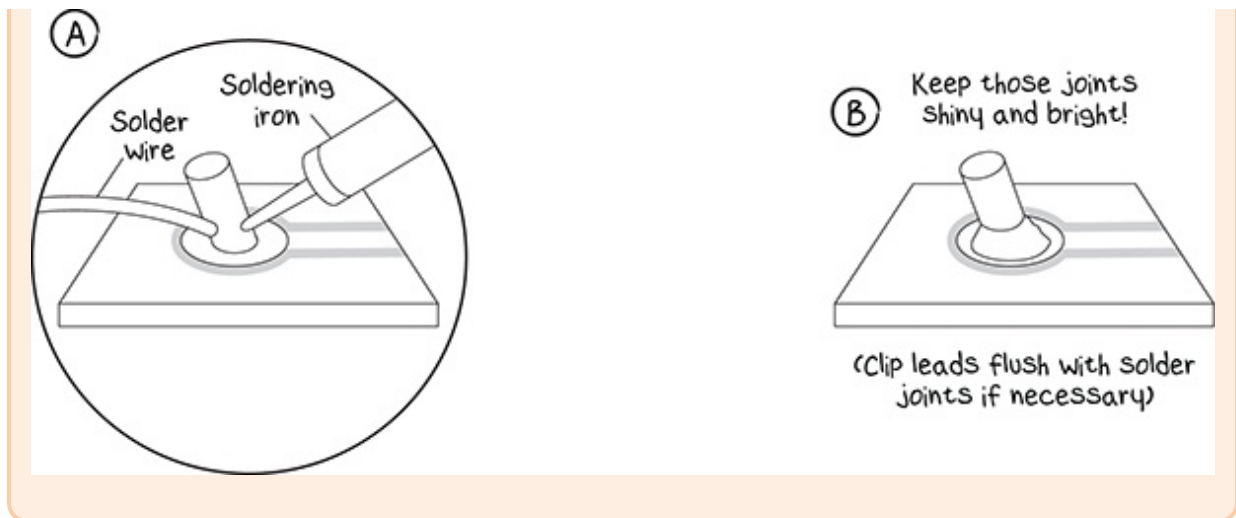
solder point. Not good. Doing this 1, 2 step without getting it backward is the main part of learning the dance. If you do solder the wire to the lead, no biggie; just heat it again, remove the wire, and start over.

And that's basically it! Let's also look at a few other important aspects of prepping and finishing your join.

To prep your component for soldering, you need to feed it through the appropriate holes on your circuit board so that the component leads protrude from the solder-pad side of the PCB (the component itself being on the printed side of the board). One way of getting the component to stay in place for soldering is to bend the leads, as shown in A in the next image. This will also bring the leads down closer to the pad so that the iron can make good contact with both the lead and the pad. If the leads are too long (so that they're in your way), you can clip them down before soldering, as seen in B below. You don't have to do this unless it makes it easier to access the solder point. For a neat and tidy finished board, make sure your components are tight and flush with the PCB on the component side before soldering. Once you have a healthy solder join, you can go ahead and clip the excess component leads so that they are flush with the solder bead you just deposited.



The A in the next image shows a good angle for iron-to-pad/lead contact and where the solder makes contact with your solder point. The B image below shows what you should end up with: plump, shiny mounds of solder that fully surround the component and make complete contact with the PCB pad. Solder joints that are dull-looking, have dark spots in them (impurities), pits, depressions, or do not make complete contact with the PCB surface and the component lead are called cold solder joints. You need to desolder) and resolder these, because they can cause component failure.



★ **DESOLDER WITH CANNED AIR**

Did you know you can use canned air for desoldering? Simply reheat and reflow the joint with your iron, point the can's nozzle away from nearby components, and give it a quick spurt to blow the molten solder away from the component lead. [\[SR\]](#)

★ **DEPOPULATE A PCB QUICKLY**

Want to quickly desolder (aka, depopulate) a through-hole printed circuit board? Place it component side down over a container and use a heat gun on the solder side. The components will quickly fall away into the container below. [\[SH\]](#)

★ **USE A BRASS SCRUBBY TO CLEAN YOUR SOLDERING IRON**

Don't use the cellulose sponge that comes with your soldering iron. Use a brass kitchen scrubby from the dollar store. The brass will clean off the tip of your iron without getting sponge gunk on it or lowering its temperature like the sponge will.

★ **SOLDERING IN THE RIGHT ORDER**

When populating a PCB, start with soldering the shortest components first and work up to the tallest.

★ **DECLAW YOUR ALLIGATOR CLIPS**

To make the alligator clips on helping-hand tools easier on components, cover the jaws in heat-shrink tubing.

★ **TAKE YOUR IRON TO TEA**

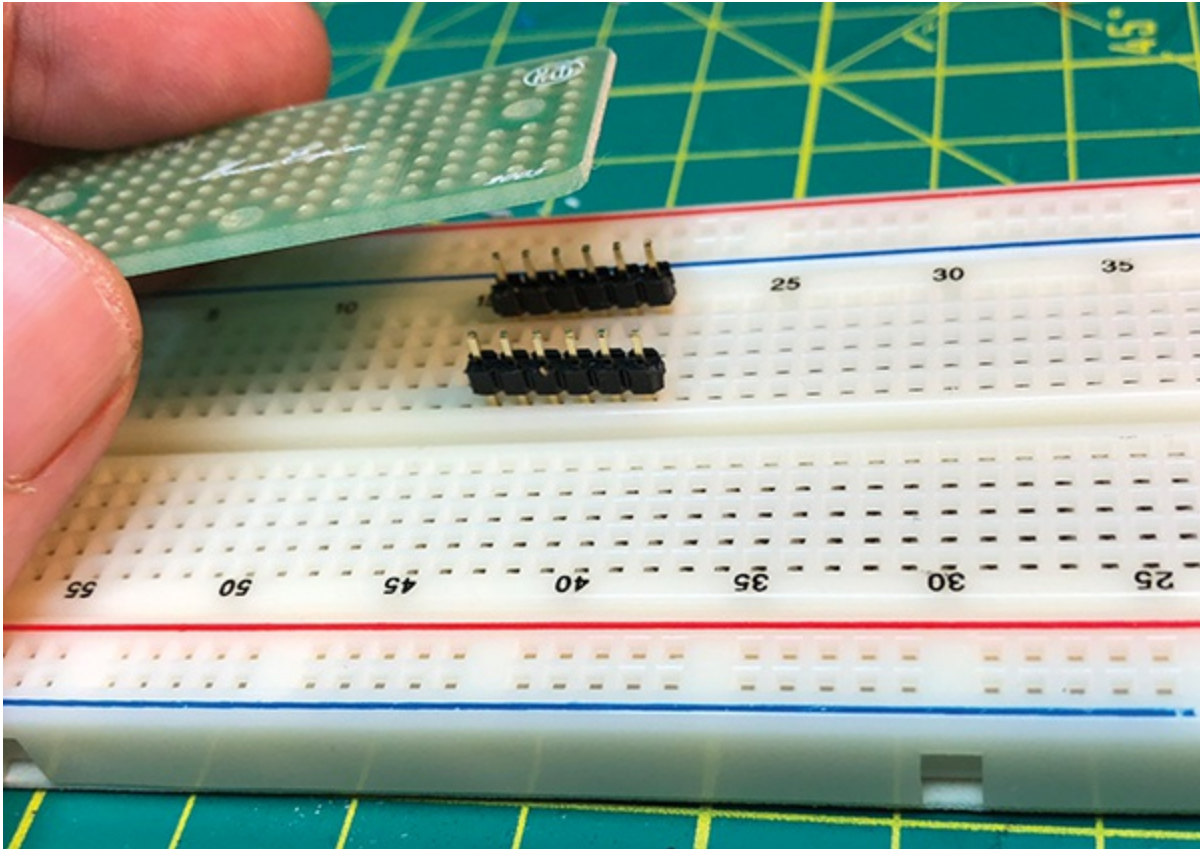
If you use a soldering sponge, wet it with tea, not water. The tea is slightly acidic and will give the iron a wonderfully clean tip. And the tea smells nice, too! [\[BL\]](#)

★ **FINISHING YOUR SOLDER POINTS**

As Donald Bell points out in one of his “Maker Update” YouTube episodes, many PCBs are so lovely these days—works of art in themselves—that you might want to add a more aesthetic finish to them. To do this, rather than side-cutting the top of the solder mound, cut as close to the board as possible, and then reheat and re-plump the points with a hit of the solder tip and some solder. What you end up with are these handsome little solder pillows. Donald has a piece on Instructables (“Make Beautiful Solder Joins”) with pictures and more details. [\[DB\]](#)

★ **HOLD 'EM STEADY**

Use a breadboard to hold header pins straight while soldering. Insert the header pins into a breadboard and then align your circuit board on top, slot the pins through the PCB holes, and solder.



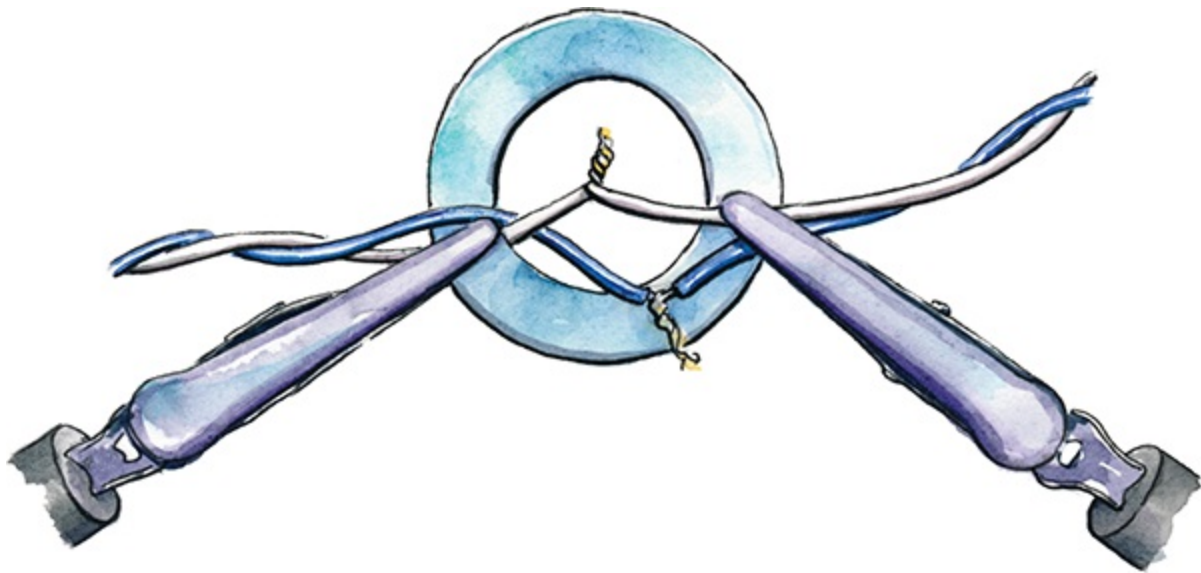
★ USING POSTER PUTTY AS HELPING HANDS

One of the great uses for poster putty is as a holder for small objects while you work on them. You can stick parts into a blob of it that you are gluing together, parts you want to paint or otherwise treat, and you can use it as an impromptu tool/parts holder/pin cushion. You can also use it in place of conventional helping hands in electronics assembly. You can press PCBs right down on it and it won't usually leave any visible residue. You'll obviously want to clean your board afterward, but you should do that anyway. Once you start to incorporate the use of this material into your electronics bench workflow, you'll likely find yourself grabbing it, rather than the helping hands, in many situations.

★ USING A WASHER TO ASSIST YOUR

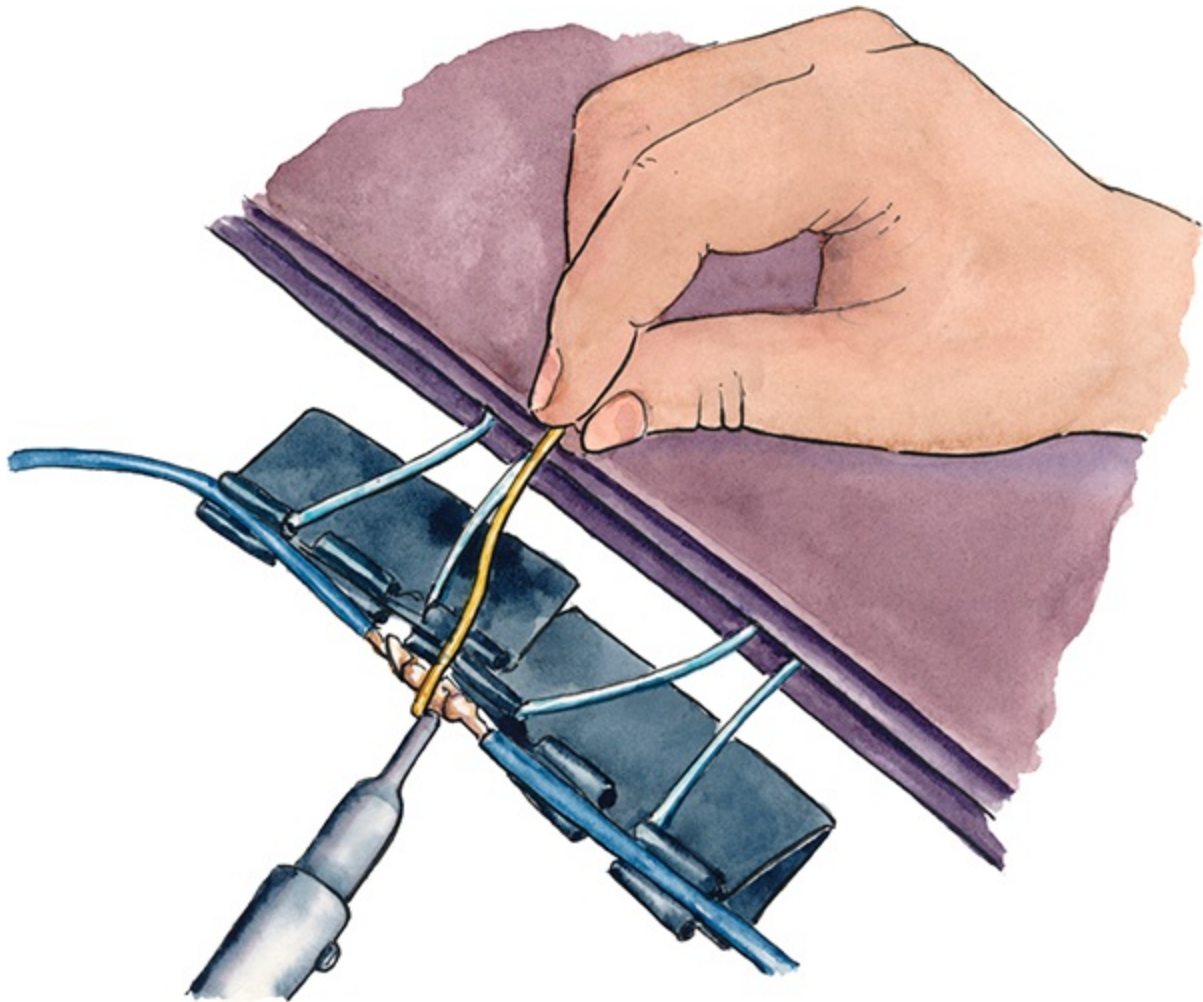
HELPING HANDS

If you have helping hands, clamping wire leads against a washer stabilizes the whole setup by connecting the two arms with a rigid member. This allows you to bear down a bit more with the iron without pushing things out of alignment. The hole in the middle of the washer still allows all-around access to the junction. If you don't have helping hands, you can just use a washer, as shown, with a pair of alligator clips (or even small binder clips) as a pretty effective improvised workholding jig for this kind of soldering.



★ USING BINDER CLIPS AS HELPING HANDS

Make: reader Antron Argav offered the following tip. Binder clips can also be used as clamps for gluing small boards or to temporarily hold anodized aluminum power resistors or TO-220 power semiconductors to a heat-sinking baseplate. I've also used them as "third hands," to stabilize small parts or wires while soldering. [\[AA\]](#)



★ **SOLDERING PROVIDES CONNECTION, NOT STRENGTH**

If you want a solder joint to last, you first need to make a solid mechanical connection between the two pieces you're connecting. Solder only makes an electrical connection; it doesn't provide much strength. [wo]

★ **SELECTING THE RIGHT TIP FOR THE JOB**

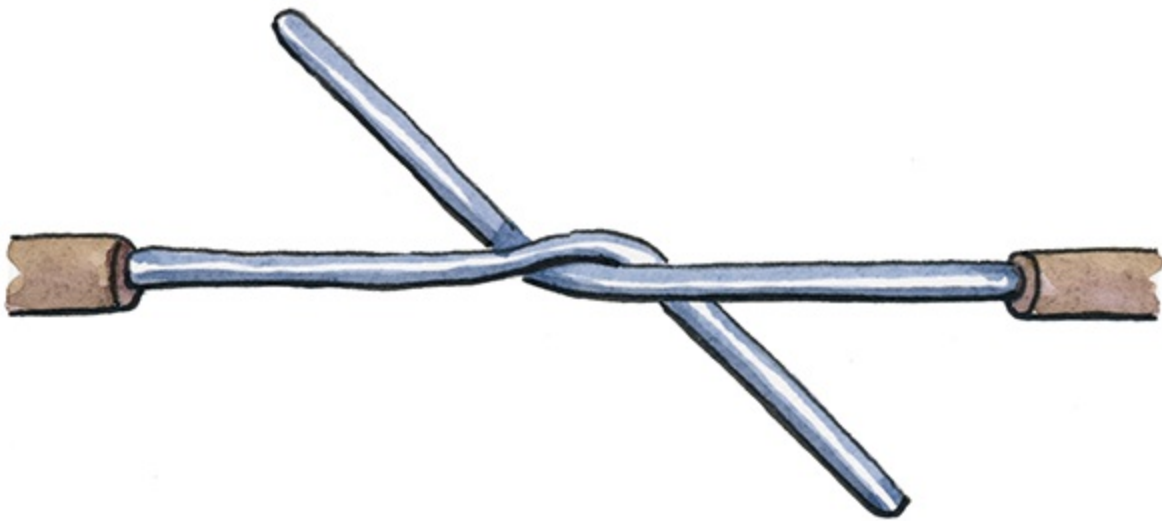
A small conical tip is great for getting into small places, such as when you're soldering the pins on high pin-count chips, for example. But don't forget to change to a larger chisel-type tip

before trying to solder anything connected to a large circuit board ground plane. The tiny tips can't deliver enough heat fast enough before the large ground area sucks all of that heat away. [AA]

SPLICING AND SOLDERING TO NASA STANDARDS

Developed during the heyday of the telegraph, the Lineman's splice is designed for connections that will be under tension. It is commonly claimed that, properly made, a Lineman's splice is stronger than the wires of which it is composed. In any case, it is a time-proven method and, coolest of all, one of NASA's Required Workmanship Standards. To wit, in a NASA-approved Lineman's splice:

1. The conductors shall be pre-tinned.
2. There shall be at least three turns around each conductor and the wraps shall be tight with no gaps between adjacent turns.
3. The wraps shall not overlap and the ends of the wrap shall be trimmed flush prior to soldering to prevent protruding ends.
4. Conductors shall not overlap the insulation of the other wire.



Though the Lineman's splice was originally used without solder, today soldering is common, and NASA insists on it:

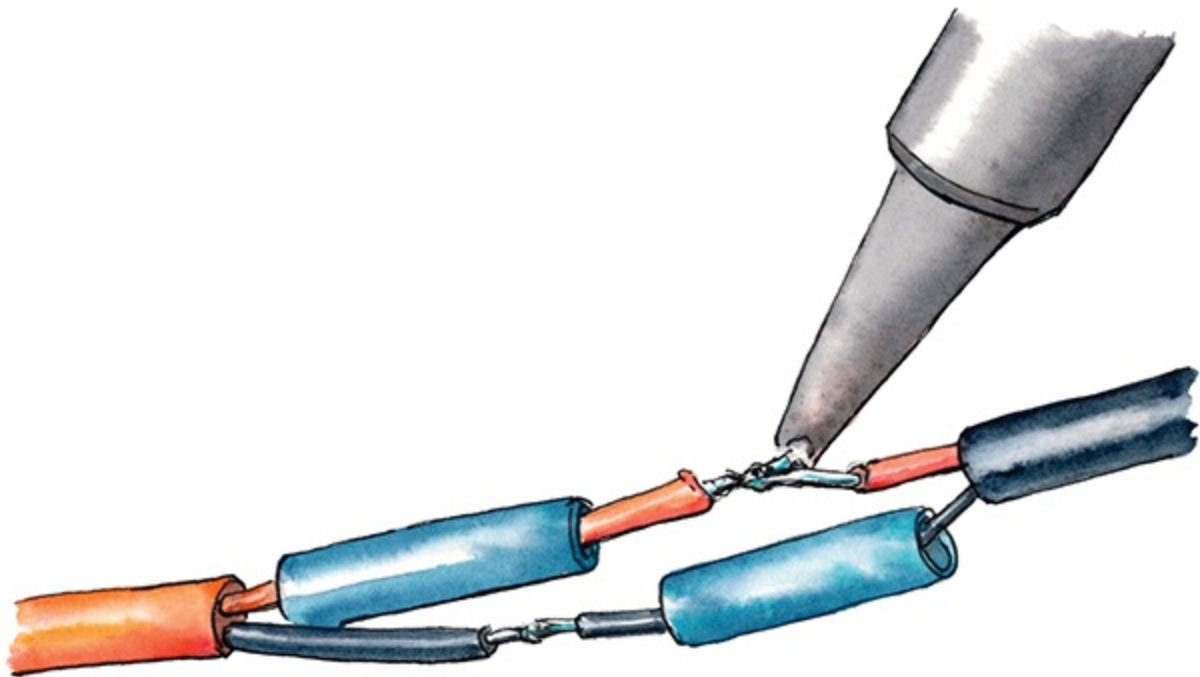
1. Solder shall wet all elements of the connection.
2. The solder shall fillet between connection elements over the complete periphery of the connection.

This material comes from page 84 of the document NASA-STD 8739.4, which is a great reference if you're interested in

best practices for interconnecting cables and wires. [SR]

★ **MAKING A SUPER CLEAN CABLE SPLICE**

In a quick technique tutorial called “Super Clean Cable Splicing” on Becky Stern’s YouTube channel, she shows off the best way of stripping, soldering, and shrink-tubing a cable splice. The trick is to offset the wire joins so that, when you add heat-shrink tubing to the individual wires and then a tube over the entire splice, you don’t get a big lump in the cable. [BS]



13

MOLDING AND CASTING

 earning the ins and outs of molding and casting may not seem like a great benefit to the average maker. It may also seem like a strange kind of unapproachable alchemy, with all of the noxious chemicals, mixed in specially marked cups, at exacting quantities. And then there's the apparent difficulty in proper mold making, casting inside vacuum chambers, and other molding and casting exotica.

The truth is that being able to create a mold and cast a part, for everything from a machine repair to Halloween costume creations, can be a huge benefit. Once you know the basic ins and outs of molding and casting, you'll be looking around the house for objects you might want to duplicate.

Here is a collection of helpful molding and casting tips that should be of benefit to every caster, from the hobbyist to the professional.

WORKING WITH EPOXIES 101

Maker extraordinaire Andy Birkey was asked by one of his YouTube viewers for any tips on working with epoxies, casting resins, and the like. Here was his response:

Follow instructions

Normally, I'm a do-it-as-you-go, seat-of-the-pants kind of guy. But when it comes to epoxy, it's chemistry; it's math. You have to do it exactly right. That's one time I don't futz with things. I just do what they tell me.

BUY THE BEST I use the best epoxies I can afford.

MEASURE ACCURATELY I use a digital scale and try to get everything as close as I can.

TEMPERATURE Make sure your temperatures are right. That's very critical to proper curing.

KNOW YOUR MATERIAL Get to know your material, and experiment as much as possible. Try it on little things that you don't care about. Get comfortable with the chemicals.

★ **GETTING BUBBLES OUT OF EPOXY**

To get the bubbles out of epoxy (if you don't have a vacuum chamber), use a heat gun or hair dryer.

★ **DISSOLVE SHAPELOCK IN CHLOROFORM**

ShapeLock plastic is a great molding and building material for lots of projects. ShapeLock, also known as polycaprolactone, becomes moldable at around 160° F and hardens to a nylon-like plastic when cooled. But did you know that you can dissolve ShapeLock in chloroform solvent? This allows you to do things like dip objects into it, cast it in a mold, or paint it onto surfaces to form thin sheets. You can buy chloroform online. [JN]

★ **DECIDING HOW THICK YOUR MOLD SHOULD BE**

Frank Ippolito of [Tested.com](https://www.tested.com) cautions that you don't want the sidewalls of your molds to be too thin, but if you make them too thick, you're just wasting mold material (and money). Frank recommends your molds be about 1/2" to 1" away from the piece that you're molding. It would be best to make it a little

thicker closer to 1g where you plan to zipper-cut (also called a jeweler's cut) the mold to provide more stability, but otherwise 1/2g to 3/4g or so is fine. **[FI]**

★ **USING LEGOS FOR MOLD BOXES**

If you've looked at any molding and casting how-tos online, or done any yourself, you likely already know this trick, but it's still worth mentioning. LEGO bricks make for a perfect, reusable, and resizable mold box, and nearly every hobbyist (and pro) who does casting uses them.

★ **REINFORCING MOLD BOXES**

Frank Ippolito recommends reinforcing otherwise flimsy pinned-together foamcore mold boxes by wrapping them in plaster-infused bandage material. This adds strength and stability and holds the box together tightly so that the weight of the mold material doesn't warp and blow out the mold box. **[FI]**

★ **KEEP YOUR SCALE CLEAN**

By way of [Tested.com](https://www.tested.com) comes this little gem for keeping your digital shop scale clean. When using it to weigh and mix epoxies, resins, and the like, sleeve the scale into a gallon Ziploc bag. The bag will bear the brunt of any yuck splashed around during your working process. **[FI]**

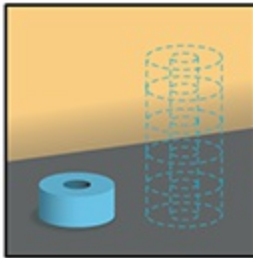
★ **CASTING YOUR OWN KNOBS**

On the YouTube channel Stuff I Made, they have an excellent little video showing how easy it is to cast your own knobs for projects. Basically, all you need are some silicone molds (like the ones used for candy making) and some epoxy resin. **[DB]**

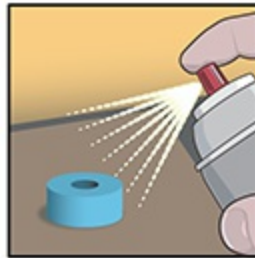
★ ROLLING EPOXY PUTTY IN FLOUR

Anyone who has ever used two-part epoxy putty, aka “green stuff,” (which a gaming industry sculptor once described to me as being like sculpting in stale bubblegum), knows that it’s very stiff and sticky and really doesn’t want to be easily manipulated. To overcome this, try rolling it out in wheat flour, like you’re baking bread. This allows you to roll it very thin. Once it’s the size and thickness that you want, you can brush off the excess flour (and wipe or wash the rest off once the piece is fully cured).

Tricks of the Trade



Need multiples of a part? Don't have any casting materials? Need it now? Use this trick from Marc de Vinck.

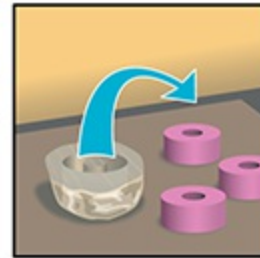


Apply a release agent to the master. If you don't have actual mold release handy, sometimes even water will work. Otherwise a light coating of oil will do.



Place the master on a flat surface (glass or parchment paper work well) and use a VERY heated-up hot glue gun to coat the piece. It may take a few tries to get the right speed down.

Tim Lillis (narwhalcreative.com)



Use the hot glue mold to cast a new piece in plaster, auto body filler, epoxy, etc. (use release agent again). You can also use this technique with caulk or sealant from any hardware store...and even JELLO! (It takes longer to cure the mold.)

★ BENDING PVC WITH HOT SAND

On the Darbin Orvar channel on YouTube, Linn has done some interesting experiments with heat-bending PVC piping. After trying to heat the outside of the pipe to bend it, she decided to try capping off the ends with duct tape and filling the insides of the pipe with hot sand. The results are impressive. For small- to medium-diameter PVC pipe, it looks like a great way to twist and form piping into whatever shapes you desire. [\[LDO\]](#)

14

SANDING AND FINISHING

Anyone who's spent a lot of time on a woodworking project knows the thrill of finally sanding it to a glassy smoothness. Then you stain, polish, and seal it, or otherwise put on the finishing touches, to bring out the full beauty of what you've created and to protect it. It's as if those final steps bring all of your labor to life, and seal in all of the time, effort, and pride you put into your work. Certain kinds of finishing processes can be a little scary (if you mess them up, you can ruin all of your hard work), but there is no greater feeling of accomplishment than when you finish these final steps. Here are a few extremely useful tips that will help make your sanding and finishing chores go more smoothly with better results.

★ **MAKING YOUR OWN CUSTOM SANDING GRIPS**

Bob Clagett of I Like to Make Stuff offered this brilliant tip on how to 3D print custom sanding grips. Using 3D design software, you can quickly design grips that conform to a specific surface on your project. If you have designed and printed the thing you're wanting to sand, you can even use the negative space information to create grips designed to sand inside of tough places. And as Bob points out, since resolution doesn't mean much here, you can print at the lowest resolution to accelerate the print time.

★ **DIY CONTAINMENT BOX**

You can easily make a simple containment box to prevent dust and small particles from escaping into the room when you're sanding small items. Basically all you need is a cardboard box, some old rubber gloves, a few layers of plastic wrap, and masking tape.



★ **STORING SANDING DISKS**

Use an old, zipper CD storage case to store sanding disks for

your hand sander.

★ **GETTING RID OF WOOD DENTS WITH WATER**

If you discover any dents from clamp teeth, or other minor deformations, when you are getting ready to sand a piece of wood, put a small bit of water on the dent. The water will make the grain of the wood swell and smooth out the dent. When it's dry, you can sand as normal. This tip was shared by Bobby on the Bobby Duke Arts YouTube channel. [\[BD\]](#)

★ **MASK AROUND WOOD FILLER**

Wood filler can stain the wood when you go to finish it. To prevent this, mask both sides of the join with painter's tape and then apply your filler. [\[JD\]](#)

★ **USING A GLOVE TO PRESERVE A WORKING BRUSH**

Jon, of the YouTube channel FarmCraft101, reminds us that you can temporarily cover a paint or stain brush by inverting your disposable glove over the brush between coats. You can also stretch the other glove over the can. This allows you to take a break without having to clean the brush or reseal the paint can.

★ **BRANDING WOOD WITH AMMONIUM CHLORIDE**

This great tip comes to us from German maker Laura Kampf. First, you mix a simple solution of ammonium chloride and water (1 tbsp of ammonium chloride to 3.4 ounces of water).

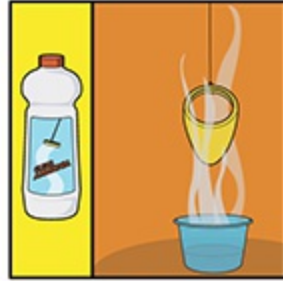
Next, apply it to the wood—you can paint it on, put it on using a rubber stamp, or load it into a marking pen and write on the wood. Then you activate it by using a heat gun until you see your image “burn in.” As Laura points out, it’s a little funkier than traditional branding, but for many applications, it’s good enough. [LK]

Tricks of the Trade

Tim Lillis (narwhalcreative.com)



Searching for an aged brass look for your next steampunk project? Use this trick, shared by Richard Nagy of datamancer.net.



Inside a sealable container, suspend your piece of brass a few inches over a small cup of ammonia.



Fume it anywhere from a few hours to a day until the desired effect is achieved. Add more ammonia if it completely evaporates.



For a burnished effect, fume the brass darker than you want it, then polish it afterward for a rich, dark, shiny, bronzed look.

15

PAINTING

When I was a wee one, getting in the way of my grandfather in his basement-cave workshop, it was watching him working with his painting tools and materials that really made a lasting impression on me. I remember the numerous coffee cans full of turpentine and brushes; his large, well-cared-for brush collection; his rows of carefully marked paints; and the paint stirring sticks with advertisements for various paint and hardware stores. Probably my first “maker project” was a painting project in Gramps’s shop. He told me I could paint something. I couldn’t think of what to paint, but I really wanted to do a project next to him while he worked. My parents had just bought me a metal Lone Ranger lunch box, so I decided I would paint that. I painted both the box and the thermos silver. It was a strange thing to do. I ended up with a generic-looking, all-silver box. My parents weren’t too happy with what I’d done, but I was proud to carry my new lunch box because I had “made it.”

I wish my grandfather was around today so that I could pick his brain for painting tips. I bet he would have some good ones. In lieu of tips from Gramps, here are some from friends and fellow makers that I have collected from conversations, YouTube videos, online projects, and the pages of Make:.

★ RE-POINTING DETAIL BRUSH TIPS

To re-point small detail brushes after cleaning them, pinch the tip into the crease of your palm (at the base of your fingers) and at the same time twist the handle.

★ **USE A PAINT SHIELD**

When you're painting trim, don't use painter's tape to mask off above baseboards and other areas you don't want paint on; use a paint shield. Paint shields are inexpensive and come in various styles and sizes. You can also use a wide putty knife, a dustpan, or even a piece of cardboard with a straight edge to shield the area you don't want to paint while you paint the area that you do. The shield is especially useful when painting baseboard on a carpeted floor.

★ **RAISE UP FINISHING WORK WITH SCREWS**

To raise up chairs and other pieces of relatively light furniture you are painting, drill some temporary screws halfway into the bottom of the legs. Just be careful not to split the wood. Raising the piece up will keep it from sticking to whatever you are painting it on and will make it easier to reach all the areas you need to.

★ **SQUEEGEE WITH A RUBBER BAND**

To give you a better, neater way of wiping paint off your brush (so you don't get it in the gutter of the lid and down the sides), create a drip stopper/squeegee in the middle of the can. You can use a bent coat hanger or even just put a taut rubber band around the can and across the center of the top. The idea is to have a rigid piece across the opening in the top of the can to scrape the brush across to clean excess paint from the brush.



★ **DON'T CONTAMINATE YOUR SUPPLY**

While many of us think nothing of working right out of a can of

paint, squeegeeing the brush over the can as we go, professional painters tell you not to do this. Always transfer a working quantity of paint into a tray or an extra paint can and work from there. When you squeegee right into the can, you are introducing dirt, dust, or anything else that the brush picked up from whatever you are painting. The less you work directly from your supply, the cleaner you will keep your paint.

★ **CREATE DRAIN HOLES IN YOUR CANS**

To prevent paint from pooling in the gutters of your cans (and spattering everywhere when you tap the lid shut), sink a few drain holes in the gutter with a nail or ice pick. [JDJ](#)

★ **TRIM CRUSTY ROLLERS**

Trim the crusty, splayed edges of your rollers at a tapered angle to prevent the edge of the brush from creating tracks as you paint.

★ **MASKING WITH ALUMINUM FOIL**

Use aluminum foil as a quick and clean masking material for door knobs and fixtures.

★ **LINING PAINT TRAYS WITH FOIL**

Aluminum foil can also be used to cover the inside pan of a paint tray, extending over the edges, so that cleanup is little more than balling up the foil. You should cover it with several layers in case the foil tears.

★ **CONCOCT A PAINT AND BRUSH HOLDER**

You can make a quick and handy paint receptacle and brush holder out of a plastic milk jug. Cut into a gallon milk jug about 5" from the bottom on the side of the jug opposite the handle. Cut from this 5" mark all of the way up and stop where the jug starts to curve toward the spout and back around, cutting away the rest of the two sides of the jug, but leaving the whole top and spout area intact. You now have a 5" deep paint tray (or however deep you wish to make it) with a carrying handle and a ring at the top where you can slot in the handle of your brush.

★ **MAKE YOUR OWN FABRIC PAINT**

You can take your favorite acrylic paint, in any color, and turn it into fabric paint simply by adding textile medium to it, which you can find in any craft store.

★ **WHIP UP A BINDER CLIP BRUSH HOLDER**

When cleaning brushes, you should never let the brush rest on the bottom of the solvent container. An easy way to create a brush holder that suspends the brush at the desired height in the solvent is simply by using a binder clip with one "pressing lever" up and one down, sitting on the edges of a jar, and the clip holding the brush in place above the cleaning solution.



★ **REVIVING WOOD PUTTY**

To re-soften a can of wood putty, simply add corn oil to the

dried-out lump, and keep adding oil until you work it back to its original consistency. [DFJ]

★ LABEL YOUR PAINT CAN BOTTOMS

On the bottoms of your paint cans, write the names of the rooms, pieces of furniture, and other items you painted with that color, so you won't forget. [CS]



★ CREATING A BRUSH CLEANING RACK

Maker Craig Smith made this three-stage paint thinner jar/rack system. The top board has 4" circles cut out of it with a circle cutting bit, and the bottom board has 3³/₄" holes so the jars cannot fall through. Four dowels glued in hold the rack together. The jars should be filled with thinner no more than ¹/₃ full. After several weeks of sitting, oil-based paints will fall out of the brushes and settle to the bottom of the jars. The now-clear thinner in the tops of the jars can be carefully poured into a container, the settled paint sludge cleaned out of the jars, and the thinner poured back in. One quart of paint thinner will last dozens of brush cleanings with excellent results and minimal waste. You can be confident in buying high-quality paint brushes to achieve superior results, and you'll be able to use them over and over.

[CS]



★ REVIVING OLD CANS OF SPRAY PAINT

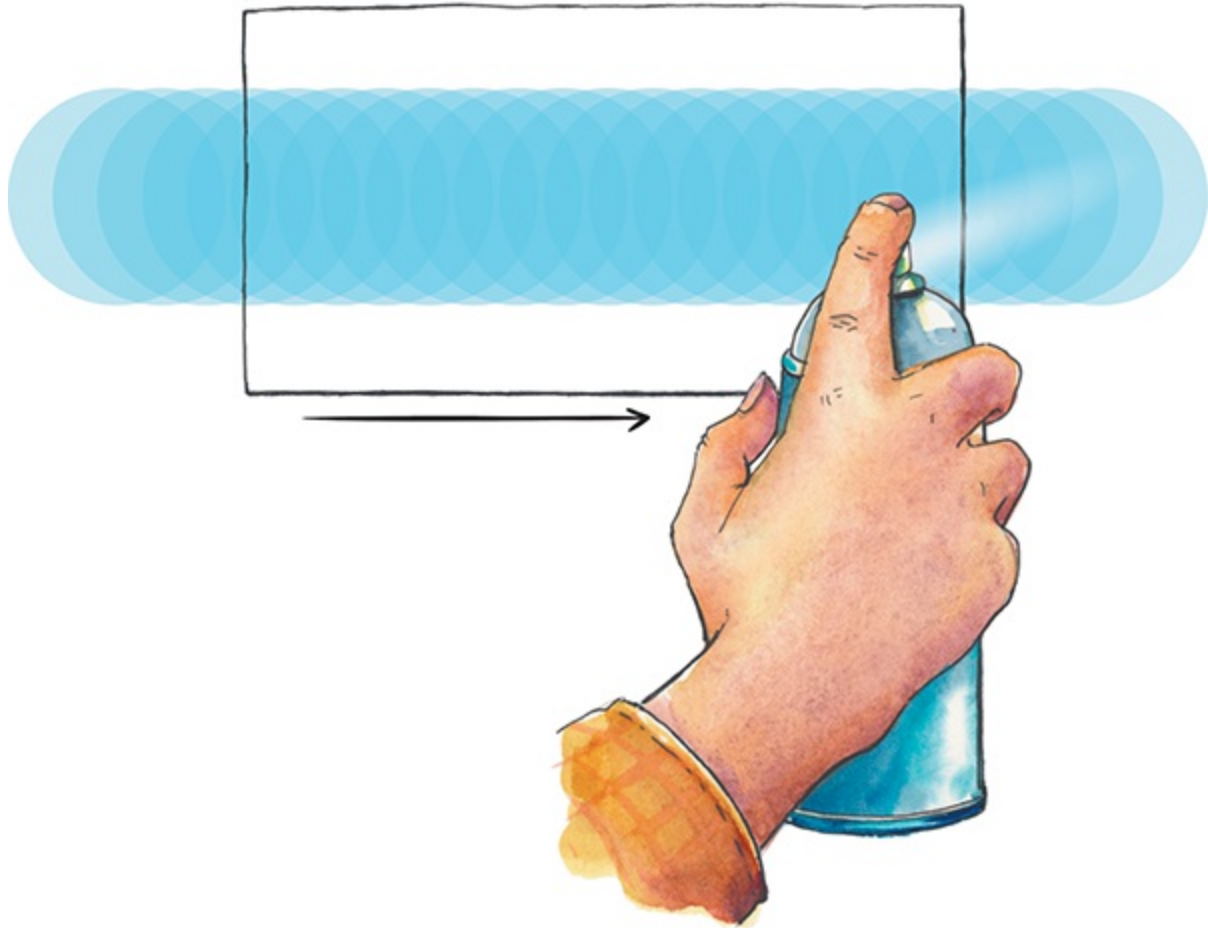
Occasionally, a used can of spray paint will refuse to spray. Remove the nozzle and soak it overnight in a solvent such as

mineral spirits or paint thinner to dissolve the gunked-on paint. If that doesn't work, try putting the can in a bucket of hot (not boiling!) water. This will reduce the viscosity of the paint, and help increase pressure in the can. Obviously, be careful not to heat the can too much. You want the contents warm, not hot.

★ **LEARN BASIC SPRAY PAINT TECHNIQUES**

First, make sure that the surface to be painted is clean, free of rust and debris, and smooth. Any surface bumps or imperfections will show through the paint, so use sandpaper or steel wool to clean and smooth the surface; then use a lint-free cloth to remove any remaining dust.

Start with a can of spray paint that is room temperature and shake it for three or four minutes to mix the paint thoroughly. You can't shake the can too much, but you can shake it too little! Be sure to shake the can occasionally while painting as well.



Press down on the nozzle, holding the can about 10" to 12" away from the surface, aimed to one side. Then, in one fluid motion, sweep the paint horizontally across the surface and release the nozzle when you reach the other side. Use your entire arm to move the can, not just your wrist, and be sure to start the spray before reaching the surface and release after passing the other edge of it.

For a large surface where multiple passes are required, overlap your passes slightly. Several light coats, allowing the paint to dry in between, will look much better than one heavy coat. Different paints dry at different rates, so read the instructions on the back of the can for drying times. Be patient; apply multiple light, smooth layers of paint (usually at least three); and your paint job will come out looking professional.

This was excerpted from “5 Techniques to Spray Paint Like a Pro,” by Jordan Bunker, makezine.com.

★ **SANDING OFF EDGES ON MASKS**

YouTube maker Laura Kampf, shared this tip for using sandpaper to create a clean edge when masking off an area for painting. Once you have the area masked off, you simply sand your mask along the edges of the workpiece with fine sandpaper to “cut” the mask cleanly away. Of course, this only works when masking defined edges and on materials that are hard enough to create a workable cutting edge. [LK]

★ **USE PAINTER’S TAPE AS A TEMPLATE**

James Floyd Kelly writes: “Stick painter’s tape to a piece of glass. Place the glass over a pattern (or lettering) you want to transfer to the tape. Shine a light from underneath the pattern and glass and you can now trace the pattern onto the blue tape. Once the image is transferred, cut it out with a hobby knife blade. Peel the tape off the glass, apply to an object, and you’ve got an instant template.” [JFK]

★ **TAKING ADVANTAGE OF THE LOW TACK OF PAINTER’S TAPE**

If you peel slowly and carefully, the low adhesive nature of the tape won’t damage paint on an item, and can even be applied to cardboard and other paper items. It’s strong enough to hold electronics components in place before soldering, and it doesn’t leave any residue (like duct tape often will) when you peel it away from plastics. [JFK]

★ **CLEARING SPRAY PAINT NOZZLES**

Here's a tip that everyone should know already (and always practice). When you are finished using canned spray paint, turn the can upside down and give it one more toot to clear any paint remaining in the nozzle (which can dry and clog it). [\[LK\]](#)

★ **STORE OLD NOZZLES IN ACETATE**

One of our online readers, BonzoDog1, says, "In addition to clearing paint nozzles by inverting the can and spraying propellant, I remove all nozzles before throwing used cans away and keep them in a jar of acetone. If a new aerosol can clogs, I can usually find a replacement."

★ **ADDING AGITATOR BALLS**

If you have hobby or craft paints in small pots or bottles, consider buying some stainless steel agitator balls (also known as tumbling shot and burnishing balls). You can get packages of these online for under US\$10. Drop one or two of these in your paint bottles, and you'll be able to mix your paints with a few good shakes. That shaking ball sound, so familiar in "rattle can" paints and nail polish bottles, is also strangely satisfying to hear.

★ **MAKING YOUR OWN PAINT WASHES**

Anyone who's ever done any high-end hobby painting, such as tabletop miniatures, scale modeling, or cosplay, knows how effective washes can be in achieving the look of realistic weathering, battle damage, and deep shading. Knowing how to use washes effectively is one of the things that separates the beginner from the more advanced painter. And if you already know this, you also know that commercial washes can be expensive and the range of colors limited. To make your own, all you need is a few drops of your desired paint color, some

matte medium, distilled water, and some empty eyedropper bottles. There are many DIY paint wash recipe videos on YouTube. Some of them add Flow Aid medium to the above recipe. This helps the wash resist clinging to high surfaces and flow better into the nooks and crannies where you want it. This tip appeared in a video on the Brush4Hire YouTube channel.

★ **MAKING YOUR OWN MATTE GLAZE MEDIUM**

Thinning acrylic paint with matte glaze medium for painting miniatures and other models can be a game-changer. Everyone who gets serious about miniature painting knows that keeping your base paints very thin and adding them in several layers makes for a much nicer paint job. But thinning the paints in water tends to separate the water and pigment, which makes it difficult to get a thin coat and achieve adequate coverage. Enter matte glaze medium, such as Lahmian Medium, sold by Games Workshop. It is designed to maintain the integrity of the thinned paint for smoother coverage. And, it turns out that you can very easily make your own (for next to nothing). All you need is a quantity of deionized (distilled) water, say 6–8 oz., into which you add 4–5 drops of matte medium (available at any art/crafts supplier). Shake, and that's it. You can experiment with the number of drops that give you the best result. I made up a batch of this and it has already made me a better painter. Being able to thin your paint, while maintaining decent pigment density, allows you to paint beautiful, thin layers. This tip comes from the Luke's APS YouTube channel.

SHARPENING

Years ago, a friend of mine, who is a knife and edged-weapons collector, told me, “A really good knife wants to cut you. That’s its job.” So there I was, with a very good knife—a Sebenza 21 from renowned knifemaker Chris Reeve. I was writing a column for National Geographic Adventure magazine on outdoor tech and Chris had sent me the knife for review. Minutes after taking it out of the box, while trying to work a one-flick opening on this brand-new knife, I cut the devil out of my thumb. I bled. I guess it was a good knife. By the way, sebenza is a Zulu word that means “work.” So, as I had been warned, it was just doing its job.

★ SHARPENING AT THE RIGHT ANGLE

Chefs and other knife enthusiasts have a world of opinions on sharpening technique, what grit stone to use, and the angle of the action. When sharpening a knife on a whetstone (a 1,000/6,000-grit combination is a good starter stone), the angle at which you hold the blade against the stone is important. For many types of knives, it is common to hold the blade perpendicular to the stone at a 15-degree angle. This angle is easy to remember, since it’s basically the angle of a book of matches. To come to your own conclusions about what angle to use, look up the type of knife you want to sharpen. There are illustrations and more details on knife sharpening in Bob Kramer’s “How to Sharpen a Knife” piece on makezine.com.

★ TESTING THE EDGE WITH A FINGERNAIL

To check the progress of your sharpening, or to assess the dullness of a knife before sharpening, hold your knife over one of your fingernails. Let the weight of the knife be its only downward pressure. Now, slowly draw the blade (still using no pressure) across your nail. If you get little resistance to your pull, then you have a very dull blade. The more resistance you feel, the sharper the blade.

★ TESTING THE EDGE WITH THREE FINGERS

Another way you can test for sharpness or dullness is called the three-finger test. You draw three of your fingers along (not across) the blade. This may sound dangerous, and it can be, so you need to be careful. First, hold the knife in your dominant hand. Place the thumb of your non-dominant hand on the spine of the blade (opposite the edge). Now put the three middle fingers of that hand gently onto the edge of the blade, at the heel of the cutting edge. Without applying much pressure at first, draw your fingers back and forth along the edge. Your brain and feedback from your fingers will tell you how much pressure you can apply. Being very careful, run your fingers back and forth along the heel, the belly, and the tip of the blade. Again, smooth means dull, resistance means sharp (and to be careful with your fingers on that knife!).

★ USE SOAP WITH YOUR SHARPENING STONE

To keep your water stone from clogging, put a little dish soap on it along with the water. You'll feel the difference. [\[TA\]](#)

★ USE A CERAMIC MUG AS A SHARPENING STONE

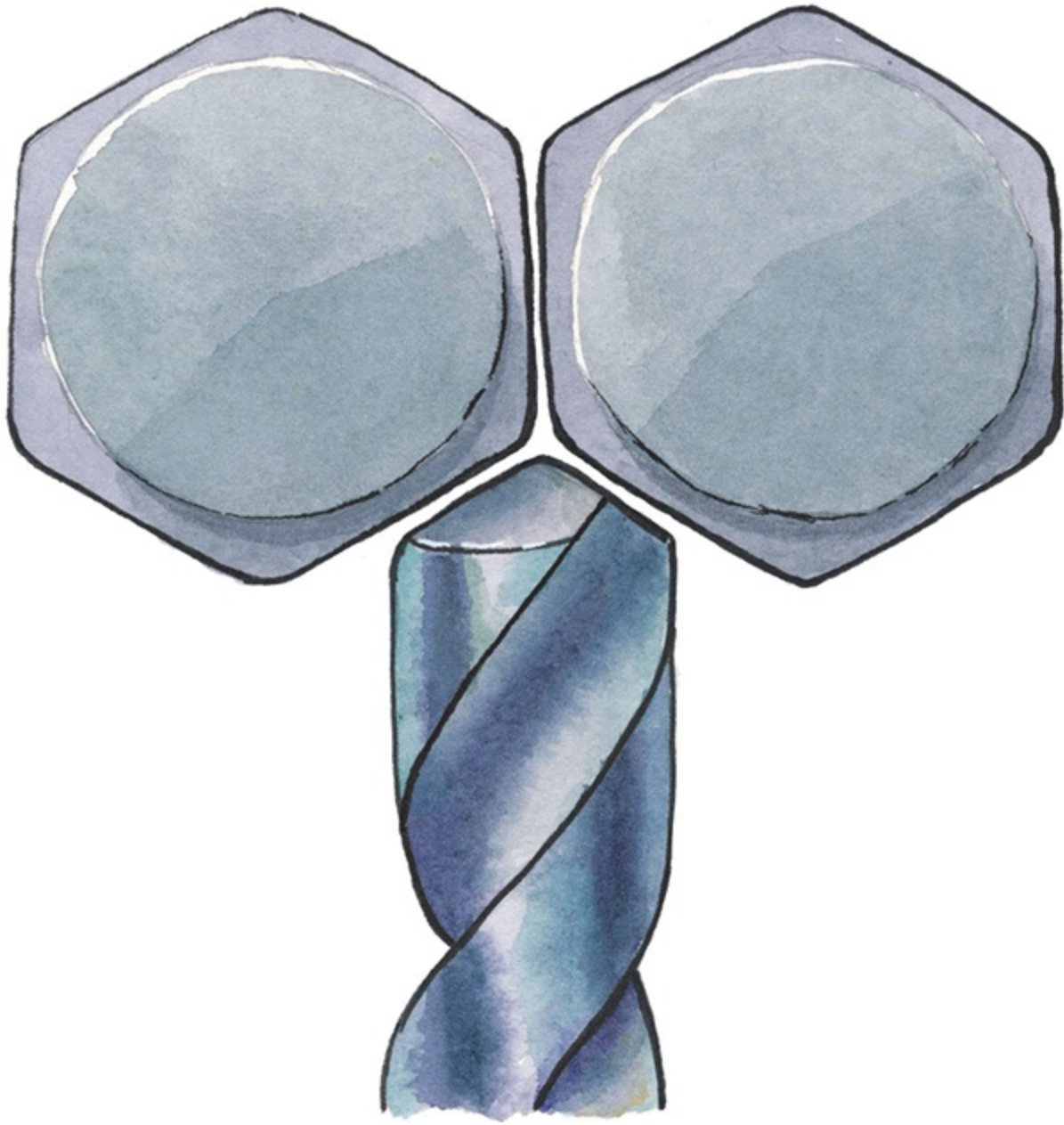
What can you do if you find yourself needing to sharpen a utility knife, pocket blade, or scissors and you don't have access to a sharpening stone? You can flip over a ceramic coffee mug and use the outer edge of the bottom (the non-glazed part) as an emergency sharpening stone. Try it. It works! [\[IS\]](#)

★ **MAKING A KEYCHAIN STROP**

To create a keychain strop for sharpening blades on the go, Linn of Darbin Orvar attaches a small strip of leather to her keychain. She smears some honing compound on it so it's ready to add an edge to any blade that might get dull in the field. [\[LDO\]](#)

★ **SHARPENING A DRILL BIT**

From the Australian site Krafty Farm Assistant comes this great little tool tip for drill bit sharpening. Get two hex bolts and nuts and mount them in a piece of off-cut steel or timber so that two of their edges are touching (as shown). Bolts of a suitable construction can be welded together to ensure they don't move.



Sharpen your drill bit carefully using a bench grinder, being extra careful not to be too heavy handed. After only a few moments of grinding, remove the drill bit and test against the two hex bolts as shown in the image.

After touching up each cutting side of the drill, your drill should fit squarely in the angle of the two bolt heads. How accurate this is depends on how close you placed the two bolts together, but this guide eliminates the need to eyeball

the angle and hope that it's right. You also need to ensure that the bit being sharpened remains perpendicular to the shanks of the bolts to make sure the cutting edges of the bit are properly angled.

★ **FLATTENING THE SOLE OF A PLANE**

To sand and flatten the bottom (sole) of your plane, leave the blade of the plane in, but back it out until it's no longer visible from the bottom. This keeps the tension of the plane body the same as it will be in use. Next, tape down a piece of the lowest grit paper and spray it with lubricant. Set the plane on the paper and move it around. Using a medium downward pressure, move it in circles, figure eights, side to side, and up and down, making sure you rub it over all of the paper. Pressing too hard won't get you where you're going any faster; it will just wear out your arm and the paper.

After a minute or two, wipe off the sole and inspect the wear. You will see smooth shiny spots appearing among the rough areas.

Continue this process, occasionally checking the sole and making sure the paper still has grit. Switch out the paper when it feels like it's no longer cutting, and add a little more lubricant if it looks dry. When the sole finally looks even and smooth, switch to the 220 paper, oil it up, and make a few long straight stokes to finish it off. If you're still feeling sassy, you can turn the plane on each side and do it all again. Lastly, drag the edges sideways over the paper to soften the corners. The sole flattening process can be tedious, but you only have to do it once, so be patient and stick with it to the end. At this point, you can pull the plane apart and wipe everything down. Make sure to get into every corner, because even a little sandpaper grit can wreak havoc with the adjusters and the edge of your blade. Rub a little paste wax onto the sole to finish it off.

The last step is to flatten the edge of the cap iron. This edge is often rough and thick with paint, which makes it difficult to achieve good contact with the blade. Simply place it on the 220 sandpaper and move it perpendicular to its length until the edge is smooth. This is excerpted from Len Cullum's "Tuning Planes and Chisels" on makezine.com.

DESKTOP FABRICATION (3D PRINTING, CNC, LASER-CUTTING)

In 2012, when I was the editorial director of Maker Media, we embarked on an ambitious project to publish the first consumer's guide to desktop 3D printing. That guide, *Make:Ultimate Guide to 3D Printing*, was a huge hit, and has morphed over the years into *Make's* annual *Ultimate Guide to Desktop Fabrication*, which now covers 3D printing, computer numerical control (CNC) routers, laser cutters, and all manner of desktop fabrication hardware. Since I was new to 3D printing myself and about to head up a team tasked with testing and evaluating dozens of printers, I figured I better set one up and try my hand at printing something. The process was far more perilous than I had anticipated. I realized this was definitely early adopter tech, and could really use a well-thought-out, reputable guide. My first prints were a mess, and in the process I learned a new slang term, "transporter accident" (referring to Star Trek's matter transfer transportation technology), for what you get when a print goes haywire. It turns out that I learned an invaluable tip in troubleshooting my problem. I had set up my printer in my apartment in Sebastopol, California, right next to the window. As you will learn below, 3D printers using ABS plastic are susceptible to drafts, causing the print to curl. Just moving my machine to a location far from drafts was all that was needed. No more mangled monsters coming from my matter rearranger. 3D printing has matured quite a bit since 2012, but the technology is still a ways away from being as turnkey and

trouble free as your 2D printer. To help you explore this futuristic world of on-demand object-making, here are some of the tips I've gathered over the years.

3D PRINTING TIPS FOR BEGINNERS

- An unlevelled build platform will cause many headaches during a print, so always check to make sure it's level before getting started. You can check this quickly by doing the paper test: Use a single sheet of paper to judge the distance between your extruder nozzle and the build platform. Set the extruder height to the first layer height, then move the extruder to all four corners of the platform and the center, with the paper between the platform and the extruder. The paper should be able to move, but the extruder should also be touching the paper at all five positions.
- Regularly clean your build platform with rubbing alcohol. The oil from your hands will keep the object you're printing from sticking to the build platform.
- When you are printing with ABS plastic, make sure you preheat your build platform to its max temperature, because preheating will help prevent edge curling.
- When printing in PLA on an unheated build platform, cover your platform with blue painter's tape. It is cheaper and better than Kapton tape for PLA adhesion.
- When you are printing on a heated platform with ABS, cover the platform with Kapton tape because it can withstand the heating and cooling of the platform better than painter's tape.
- Are your prints still not sticking to the Kapton? Or do you have blue painter's tape covering the building platform? Try covering the surface with hairspray. Many

people have tried this solution and have seen increased adhesion between the object and the build platform.

- When you are printing an object for the first time, do it on the lowest quality setting of the printer. You do not want to find out after hours of printing that the object is 1mm too small!
- Know the plastic you are printing with. The two most popular types are ABS and PLA, and each has its own characteristics, like melting temperature and extruding speed. Don't forget to make sure your printer's profile is right for the plastic you are using.

This is an excerpt from Michael Overstreet's "Helpful Tips for the New 3D Printer Owner" in the 2013 Make: Ultimate Guide to 3D Printing. [\[MO\]](#)

★ **BLOCK THAT DRAFT!**

If you find that your print is curling, even after following the above beginner tips, try putting some paper or cardboard around the bed (if you have an open-sided printer) to block airflow. Even a slight breeze from movement around the printer can be enough to cool the print down and cause problems. Anything you can do to block airflow can be helpful.

★ **USE MAPLE SYRUP FOR WHAT?**

People use all sorts of weird stuff to create a bed adhesive for holding down ABS plastic prints on a 3D printer. Some people use special papers, glues, sprays, and tapes, as well as glue sticks, hair spray, and painter's tape. But the weirdest of them all must be maple syrup.

★ **GO AS LOW RES AS YOU CAN**

Before you decide on the resolution of your print, think about the print's application. If you don't need a high-resolution print, try a lower-resolution setting. It will save you time, material, and wear and tear on your machine. [BC]

★ **IS YOUR FIRST PRINT LAYER ALL SQUISHY?**

If you find that your first print layer on your 3D printer is all rough and squished-looking, you likely have the extrusion head too close to the print bed. On most printers, the thickness of a sheet of bond paper is the normal distance between extruder nozzle and the bed. If you notice a skipping sound coming from the extruder mechanism, it means that too much filament is being extruded, which can also make for a squished print. To fix this, recalibrate your extruder, aiming for that paper-thickness distance.

★ **USE TEST PRINTS**

You can download a number of files from [Thingiverse.com](https://www.thingiverse.com) that will help you test out the capabilities of your printer. You can also use them to test new filaments, or to make sure the bed on your printer is properly level and in a good mood before you print your precious project. Search "3D Printing Tests" to see the files that are available.

★ **TRACING PHOTOS OF OBJECTS FOR 3D DESIGNING**

Bob, of I Like to Make Stuff, wanted to build a human-sized prop of the coveted Optimus Prime Blaster Cannon from his childhood. To get an accurately scaled and detailed 3D model of the prop for 3D printing some of its parts, he simply took a photo of a tiny Blaster toy, brought it into Fusion 360, and then

traced, revolved, and extruded to create the shapes for his gun. With a camera, a CAD program, a 3D printer, and tons of time and patience, you can print out the world—or at least a prop version. [\[BC\]](#)

FIXTURING TIPS FOR CNC

One of the challenges of getting started with CNC routing is deciding how to hold down parts reliably. As a luthier, I make a lot of odd-shaped parts out of a variety of materials, and I've developed methods that work well for different needs. They're also applicable to many other kinds of prototyping or manufacturing in the small shop. Making fixtures for your CNC is a great way to get to know your machine, and it will open your eyes to all the great things you can do with it!

Hold-down method	Best applications	Strengths	Limitations
T-track clamps	Large pieces of flat stock, securing other fixtures	Fast and easy to use	Can get in the way of cutter or dust shroud
2D vacuum clamp	Production parts larger than 10" square with a flat bottom surface	Fast once set up, holds down the entire part with even clamping pressure	Time-consuming to make; additional cost of vacuum setup; parts normally can't have holes
3D vacuum clamp	Production parts with a machined 3D bottom surface that must be held while you machine the other side	Fast once set up; holds down the entire part with even clamping pressure	Time-consuming to make; additional cost of vacuum setup; parts normally can't have holes

Universal vacuum	Relatively large parts cut from sheet stock (e.g., cabinet parts)	Fast to use; can hold an entire sheet while you cut parts from it	Requires a large vacuum source; parts need to have a large surface area
Double-sided tape	Flat parts of nearly any size	Fast and easy to use, perfect for one-off parts and prototypes; easy to remove, yet very strong if it sticks well to the stock; has some flexibility	Can release unexpectedly if not enough tape is used or tape doesn't adhere well to surfaces; can be expensive if you use a lot
cyanoacrylate (CA)	Small flat parts	Holds even tiny parts securely	Works best with impervious materials; must be dissolved with acetone to release; can be brittle
Vise	Small to medium-sized parts that don't have a large flat side on the bottom or can't be held securely by other means	Can hold odd-shaped parts very securely	Requires a machine with higher Z-axis clearance

The heart of my CNC setup is an MDF "spoilboard." I never cut into it on purpose, as you would with a traditional spoilboard. The working area has been surfaced with the CNC, and has two T-tracks for using hold-down clamps. It also has a series of bronze bushings installed along the centerline that receive 1/4" steel dowel pins for indexing many of my fixtures. Each fixture has matching bushings. I just place the fixture on the

spoilboard, locate it with two pins, and hold it down with four clamps. This takes a matter of seconds, and I know that the fixture is reliably positioned and secure. Once I've "homed" my machine, I can cut without resetting my X and Y axis coordinates, because I know exactly where the fixture is on the table.

I use a variety of methods for holding the actual workpiece to whichever fixture I'm using. Each has its strengths and weaknesses, based on the geometry of the part and the time you can a lot to making a dedicated fixture for it.

Clamps

I use my T-track clamps mostly for holding down other fixtures, but they're also great for holding down large pieces of stock if you're sure they won't get in the way of the cutter or dust shroud. I have a few chunks missing from my clamps from cutting into them accidentally!

Vacuum

For parts with a large surface area (larger than about 10"²) and no internal cutouts, vacuum clamping excels. It takes some time to make vacuum clamps, so they're usually best for parts that you plan to make repeatedly. The vacuum system need not be too expensive—for around US\$150 you can get a small pump and all of the necessary fittings. The cubic feet per minute (CFM) required depends largely on the porosity of your fixtures and your workpiece, but I manage fine with a 3 CFM pump. If you have a large-capacity compressor, you can also use a Venturi system, which will create a vacuum from compressed air.

I like to use quick-release fittings that make it easy to attach the vacuum hose to each fixture. A vacuum-clamping fixture has an internal air hole running from the quick-release fitting to the interior area of the part outline, where it is then connected by a vertical hole to the top surface of the fixture. A grid of grooves under the part helps distribute the vacuum evenly. Finally, a gasket just inside the perimeter of the part seals the vacuum. For this I like to use 1/8" or 1/4" close-cell foam rod set in a groove. When the vacuum is turned on, the rod compresses in the groove so that

the workpiece sits completely down on the surface of the fixture, ensuring that it is located accurately in the Z (vertical) axis. Nonporous materials such as acrylic or HDPE work best for most vacuum fixtures, but MDF also works surprisingly well if you seal all its surfaces with a few coats of shellac or other wood finish. Because there will be some air leakage, you have to make sure your pump can keep up with it.

In addition to flat vacuum fixtures, you can make 3D ones, which can hold an odd-shaped part after you've machined one side and flipped it over to work on the other side. I use 3D vacuum molds to hold the arched surface of mandolin and guitar tops and backs while I carve the concave interior side.

You can make vacuum fixtures for holding several small parts if you devise a system for distributing the vacuum to each part. For making fretboards I have a fixture with several "zones" that I can turn off and on individually in case I don't want to use them all at once. Each zone corresponds to a "fixture offset" on the CNC. I've found that $\frac{1}{4}$ " drip irrigation and tubing work very well for distributing the vacuum to each zone, and are inexpensive. You can get little valves that you can set right into the surface of the fixture.

There are also "universal" vacuum clamping setups, where a high volume of air is pulled through holes in the entire table (or just through porous MDF). This is widely used by cabinet makers, but requires a much larger vacuum pump, and parts with a large surface area.

Double-Sided Tape

For holding down one-off parts where you don't want to take the time to make a dedicated fixture, double-sided tape works great. Thin carpet tape holds well but can be hard to remove and will gum up cutting tools if you're cutting all the way through the part. I've found that Scotch Permanent double-sided tape works wonderfully. It won't gum up bits and is easy to remove, yet holds even very small parts well. I use it for wood, plastics, and sheet metal. If I am going to be cutting all the way through a part, I'll clamp a sacrificial piece of MDF down, and then use double-sided tape to secure the workpiece to that. You can also use a combination

method, where clamps help hold the stock to keep it from shifting during aggressive cutting passes, and double-sided tape keeps each part from shifting as it is released from the stock.

Cyanoacrylate

For the tiniest parts, cyanoacrylate (CA) excels. I cut a lot of inlays out of mother of pearl and abalone, and I use medium-viscosity CA to stick the shell blanks to a thin piece of phenolic backer board, which in turn is held down to an indexed fixture with double-sided tape. I scan a sheet of positioned shell blanks on a flatbed scanner beforehand, so I can import the image into my CAD software, allowing me to know the exact X and Y coordinates of each shell blank. Then, when I need to cut some inlay pieces I can just put the whole fixture on the machine, index it with the two steel dowels, clamp it down, and cut away. I regularly cut pieces smaller than 1 mm wide with this method. After cutting out my inlay pieces, I cut through the phenolic sheet around the perimeter of the used-up shell blank, free just that blank from the double-sided tape, and soak it in acetone for a few hours to release the tiny inlay pieces. For sheet brass and other metals, you can try CA, but sometimes heat expansion of the metal during cutting causes it to release from the brittle CA. For this reason, double-sided tape may work better, because it allows for slight movement.

Vises

Vises are great for holding awkward parts that don't sit flat on the work surface. They can hold even small parts quite securely, so you can make bold cuts without fear of them shifting. However, vises take up valuable Z-axis space on your machine, so be sure you have enough vertical space before buying vises. Adequate Z-axis height is an important factor to consider when purchasing a CNC router, especially if you plan to stack spoilboards and fixtures. I have my vises permanently attached to a sheet of MDF with indexing bushings installed, so they're easy to put in place.

—ANDREW MOWRY

★ **FINISH YOUR PRINTS IN CHEAP CRAFT PAINTS**

You can get pretty decent results from painting 3D prints with cheap acrylic craft store paints. Brands like Apple Barrel, DecoArt, and Craft Smart are cheap, readily available, and easy to use, and offer a very respectable result.

★ **ADDING PATTERNS TO YOUR PRINTS**

If you want to add color, pattern, and visual texture to your 3D prints, try using hydrographic film (aka water transfer film) which is a water-soluble material with images on it. To use it, you put it in a bath of water and spray with an activator, and then dip your printed object into the bath. The print on the film is then transferred to your object. Hydrographic film is readily available online.

★ **3D PRINT PARTS FROM MCMASTER-CARR**

Make: contributor Meredith Scheff-King discovered a feature within the indispensable McMaster-Carr catalog that could be a godsend to makers who have access to a 3D printer. Many parts in the online catalog have 3D models attached to them. In an Instructable called “Download, Edit and Print Your Own Parts from McMaster-Carr,” Meredith shows you where to get the STEP files (a common format for 3D design files) so that you can download them, convert them to STL (a digital file format commonly used in 3D printing), load them into a CAD program, and prepare them for 3D printing. Now you can print a critical part, test-fit it, and make sure that it’s the part you want before buying it. Pretty cool, eh? [\[MSK\]](#)

★ **WORKHOLDING, QUICK AND DIRTY**

There are plenty of great workholding options for CNC projects, but if you need something simple, strong, and fast, hot glue is one of the best. Place a small dot every 3" or so and press it into your spoilboard (the disposable work surface used on a CNC bed). You shouldn't even need tabs to keep your workpiece in place. When you're done, use a putty knife to pry it off, and swab the glue with some denatured alcohol to break the glue bonds. [TW]

★ **USE A LOUPE TO INSPECT YOUR BITS**

CNC router bits don't last forever, and not all of the wear and tear that they receive is visible to the naked eye. Getting a magnified look at a bit's cutting surfaces can tell you plenty about why your cuts aren't turning out the way that they should. [TW]

★ **SAVE YOUR LAPTOP**

If you don't have a dedicated computer to drive your CNC machine, don't subject your nice laptop to sawdust. Chances are that you can use a humble Raspberry Pi running Universal GCode Sender to drive your CNC router. These devices don't have any fans to get clogged with dust, they consume very little energy, and they're cheap to replace if they ever bite the dust (literally!). [TW]

★ **DOUBLE DOWN ON DIGITAL FABRICATION**

If you have access to a 3D printer, don't overlook its utility alongside your CNC machine. There are some pretty big collections of parts on [Thingiverse.com](https://www.thingiverse.com) to make your CNC router better—clamps, dust covers, and air diffusers. You can also use your printer to create custom jigs for workholding, customized clamps, and more. The two machines work

beautifully together, though not necessarily side by side. [TW]

★ **SKIPPING THE TABS ON CNC PRINTS**

Josh Price of The PI Workshop offers this tip for forgoing CNC support tabs. When you're using double-sided tape to secure your piece to the worktable, arrange the tape in a herringbone pattern. This way, you will "catch" the pieces that you're cutting out so that you don't have to include tabs in your design. After the machine is finished doing its business, carefully pry away the waste material, and your cut pieces will remain stuck to the tape and the worktable where they can be carefully pried up. [JP]

👉 **CLEANING STENCIL MACHINE CUTTING MATS**

Besides 3D printers, CNC machines, and laser cutters, a popular type of machine showing up more often in the shops of desktop fabricators are die-cutting/stencil-making machines, such as Silhouette and Cricut. Graphic artist Sara Conner Tanguay, of Wartooth Designs, offered this tip on a private Facebook makers group.

You can bring your Silhouette or Cricut cutting mat back to life. This is the fourth time I have redone my mat. Follow these simple steps:

1. Schmear on some Goo Gone.
2. Use a razor blade to scrape off all of the boogery crap.
3. Give it a good bath in warm, soapy water. After drying, give it a final wipe-down with rubbing alcohol.
4. Tape the edges off and spray it with low-tack repositionable spray adhesive.

Ta-da! Good as new!

★ **COLOR-TINTING LASER ENGRAVING**

From the YouTube channel, Laser Wood Minnesota, comes this great tip for coloring fine-detail laser engraving. Take a dye meant for coloring epoxy (such as TransTint), and mix it with denatured alcohol. Apply it to your workpiece (it's easy to apply) and simply wipe the surface clean, which leaves only the deeper engraved surfaces with dye in them.

TIM DEAGAN'S QUICK TIPS FOR HIGH-TECH LEATHERWORKING

Modern Leatherworking is written with two kinds of makers in mind. The first audience consists of digital fabricators who own 3D printers, CNC machines, vinyl cutters, or laser engravers who are looking to expand the range of materials that they can work with. The second audience consists of leatherworkers who have been wondering what digital fabrication techniques can offer them.

The book is intended to serve as a bridge to, and a jumping-off point for, both groups; here are tips that everyone can use.

Tips

- When you're using a laser to cut or engrave leather, the leather can be wet or dry. Wet leather creates less charring and has less smell, but the leather may shrink upon drying. Dry leather stays dimensionally accurate, but has a deeper char and produces considerable smoke.
- Hand-stitching leather is still the most versatile and useful way to assemble leather pieces, but using a CNC or laser to create the stitching holes makes it fantastically easier!
- Make your own custom-sized or -shaped double-sided tape by using adhesive shelf-liner. Stick one piece to the worktable and the

other to your leather. Use spray adhesive or CA to glue the two pieces together. When you're done, peel the leather away from the shelf-liner and the shelf-liner away from the worktable just like (expensive) double-sided tape.

- Try dyeing and finishing leather before engraving on it with a CNC. This will make the engraved parts lighter than the dyed parts for a high-contrast look. For the opposite effect, use a finish like Super Shene on the leather, before you engrave it. You can then use antiquing gel to darken the engraved parts without darkening the rest of the leather.
- You can use "found" leather from thrift shop belts, boots, and bags to make really interesting customized projects by using digital fab techniques like CNC, laser engraving, and 3D-printing. For example, you can make conchos. Dyeing these items can be difficult, but don't overlook using vinyl cutters to make custom stencils for painting them!

**FROM TIM DEAGAN'S MODERN LEATHERWORK FOR MAKERS:
TRADITIONAL CRAFT TECHNIQUES MEET CNC AND 3D PRINTING
(MAKER MEDIA, 2017)**

18

SEWING

Alongside soldering, sewing is one of the skills I frequently tell makers and DIYers of all stripes that they should learn. The basic techniques of sewing can come in handy for all manner of issues in project execution, as well as for maintenance and repair. As with soldering, many people are intimidated by sewing, but they shouldn't be. Learning how to thread a needle, the basics of operating a sewing machine, and a few basic stitches and what they are used for can arm you with a very useful and fundamental life skill. Here are a few tips to help you along in this effort.

★ **THREAD A NEEDLE THE EASY WAY**

Here's a very clever method of threading a needle. Basically, you place the thread across the palm of your hand, place the eye of the needle perpendicular to the thread, press the needle into the thread, and wiggle it back and forth across the thread until a loop of thread gets worked through the eye. Pull on that loop and you are done. It's useful (if you don't have a needle threader handy), and it feels kind of like a magic trick at the same time.

★ **USE PINS WISELY**

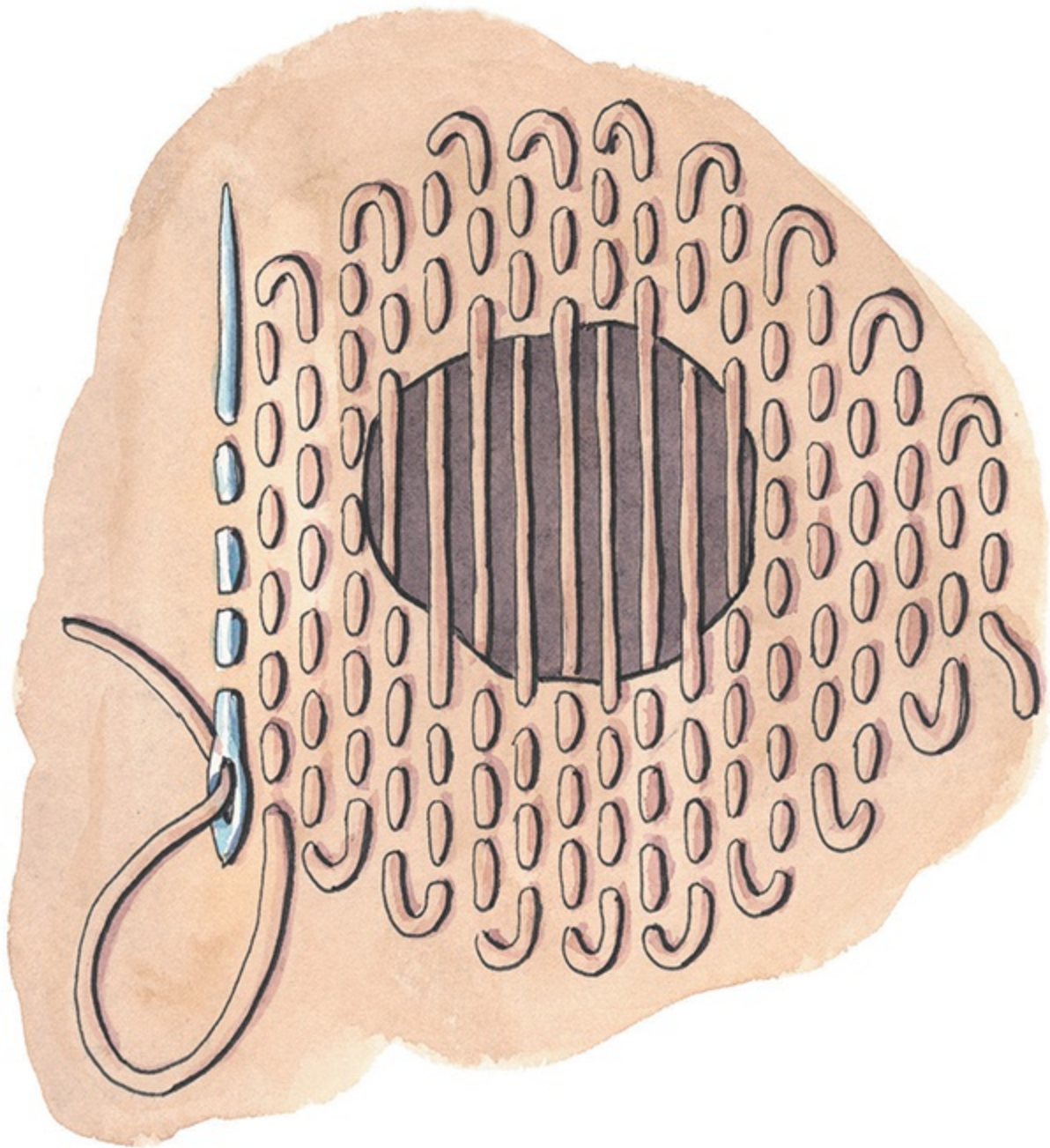
If you're sewing slippery fabric, or if you're sewing together two or more pieces of fabric that don't lie flat on top of one another—for example, if you're sewing a gathered piece to a non-gathered piece—then using lots of pins will help you get a

neat result. Sometimes, however, lots of pins can have the opposite effect. If you use too many pins, they will keep the pieces from lying flat against each other. So, for basic assembly, use the fewest pins you need to hold the pieces in place. A related tip is to pin perpendicular to the edge with the pin heads sticking out so they don't distort the fabric. [\[TW2\]](#)

DARNING A HOLE

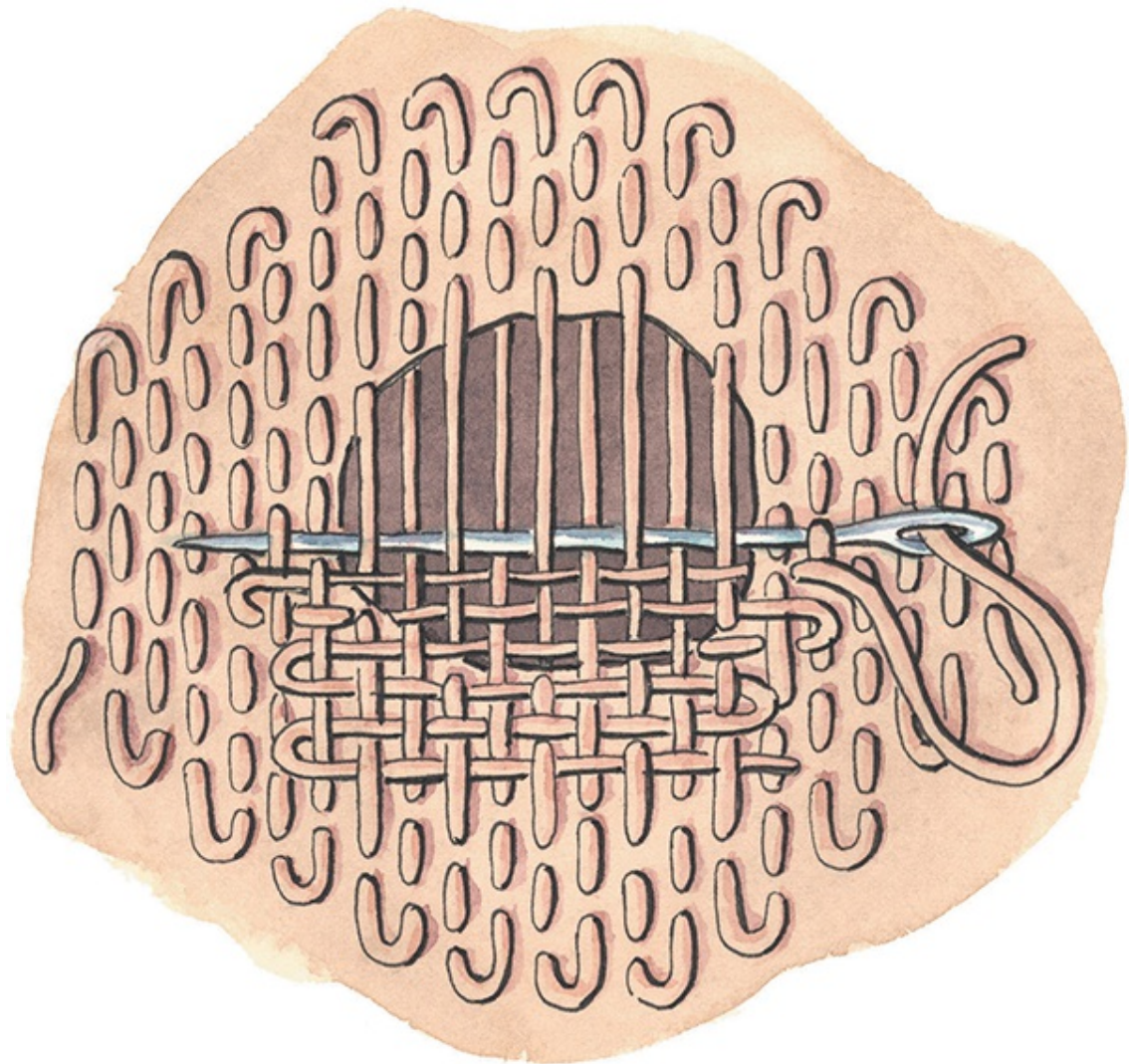
The following instructions on how to mend holes in fabric are taken from Make Do and Mend, a booklet that was issued by the British government during WWII. A screen capture of the page has been a viral favorite on the web whenever the subject of darning clothes comes up. What would “Mrs. Sew and Sew,” the credited author of the publication, have thought if she knew that her instructions would be whizzing around the globe in a vast and largely invisible electronic network nearly 80 years later?

First, clear the loops of fluff and broken ends of threads from knitted garments or clip away ragged edges from machine-knit fabrics. Always use a darning ball under large holes.



1. Make the darn in the shape of the hole.
2. Darn up and down the hole first—work on the wrong side.
3. Choose mending thread as fine as the material of the garment.
4. Begin a good distance away from the hole in order to reinforce the thin parts around the hole.

5. Space the rows of darning the width of a strand of mending thread apart.
6. Pick up the backs of the loops only, unless the material is very fine.
7. Leave loops at the ends of the row and darn so that stitches alternate with spaces between stitches in the previous rows.
8. Pick up the edge of the hole in one row, and then go over the edge of the hole in the next row. If you have cleared the edges of the hole, you will find this will be easy and will make a neater mend on the right side of the garment.



9. Continue the darn over the thin place beyond the hole.
10. Only darn beyond the hole about two stitches.
11. Leave loops at the ends of each row and only pick up the darning stitches on the needle.
12. Pick up the alternate strands of mending in the first row.
13. In alternate rows, pick up the strands of mending you passed over in the previous row.

★ **DON'T FORGET TO CHANGE YOUR NEEDLE**

It's easy to forget to change the needle on your sewing machine. A dull needle is not your friend or a friend to the fabric it is attempting to cut through. Sewing machine needles should only be used for six to eight hours of machine time before you replace them. And if you're hand-sewing and getting a lot of resistance from the fabric as you stitch, consider getting a new needle to see if that helps.

★ **DRAW THE STITCHING LINE ONTO YOUR FABRIC**

This might sound like cheating, but if you are preparing to sew a corner, or perhaps an even more complex shape such as a scalloped edge, try drawing the stitching line onto the wrong side of the fabric (or interfacing) to help you see exactly where you need to pivot or turn your stitching. Use a chalk pencil or washable pen so that the mark comes out afterward! **[TW2]**

Tricks of the Trade

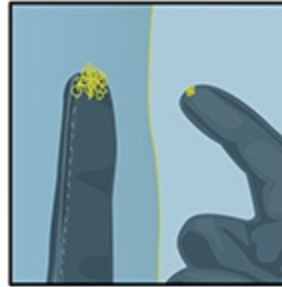
Tim Lillis (narwhalcreative.com)



Have you ever tried to use your touchscreen device with gloves on, to no avail? Steve Hoefer at Grathio.com has shared a great solution.



All you need is your gloves and a little conductive thread, available at Sparkfun.com.



Now sew through the tip of the index finger, leaving lots of messy loops on the inside to ensure contact with your finger. You want the thread on the outside to be a nice little nib.



You're ready to touch that screen in all conditions! You can even do the same thing to your glove's thumb if you want to use the device's pinch and zoom functionality.

🧵 5 COMMON SEWING MACHINE MISTAKES AND HOW TO FIX THEM

When you first start using a sewing machine, you will inevitably make mistakes. It's easy to forget—or just not realize—all of the little things that can cause your machine to throw a tantrum if you're not careful.

1) The needle unthreads itself when you start sewing.

You just threaded the needle, and as soon as you put your foot down on the pedal, the thread decides to come out of the needle. Rats! This is simple to solve: First, make sure you have a few inches of thread pulled through the needle and out toward the back of the machine before you begin. Second—and this is something it took me a little while to discover when I first began sewing—check that your needle is at the highest position before you start stitching. How can you tell if your needle is all the way up? Make sure you can see the silver hook (or take-up lever) at the top of your machine. If you can't, simply turn the handwheel toward you until the hook emerges (or press the up-down button if your machine has one).

2) The fabric is jiggling around like crazy.

Lower your presser foot! The presser foot holds the fabric in place so you can stitch neatly, not freestyle.

3) The stitching is really uneven.

If the stitching looks loopy on one side and tight on the other, your first reaction might be to blame the thread tension setting on your machine. Sometimes you'd be right, in which case, try adjusting the tension dial and test-sew on a scrap of fabric until the stitching looks even on both sides of the fabric. Often, it's not the tension dial, it's the way you've threaded the bobbin, which also affects the tension. Take your bobbin out of the case and check to make sure that you've inserted it the right way, usually with the thread unwinding counterclockwise. Also make sure that the thread is pulled through the grooves in the bobbin case. Do check your machine's manual, though, in case it's different.

4) Your stitching is crazy tight on the top side.

Again, this could mean you need to adjust the tension dial, but first, just check that your spool thread isn't caught on the little silver tension discs on top of your machine. You would have put the thread here earlier in winding the bobbin, but when you thread the machine, you need to take it off; otherwise, it creates too much tension in the spool—and super tight stitches.

5) The threads are knotting up.

Another really common issue is where your threads knot up, either on your fabric, or worse, they get jammed up in the machine and you have to yank them out or even unscrew the needle plate to get them out. First, before you start sewing, check that both the spool and bobbin threads are sticking out toward the back of the machine; otherwise, they can get twisted up in the stitching. Second, start sewing a few millimeters in, rather than right on the edge of the fabric, then backtack a bit so you don't leave any gaps in the stitching. If there's not enough fabric under the needle when you begin stitching, the spool thread will get tangled up with the bobbin thread underneath it and cause knots. Sometimes the needle will push the edge of the fabric down into the bottom of the machine to join the threads in one big awkward mess. Yikes! For the same reason, when I finish a line of stitching at the end of a piece of fabric, I always backtack a few millimeters before the edge and then stitch off the end so I don't leave any holes. Otherwise, if you stitch off the end and then try to

backtack over the end, your threads will get tangled.

–TILLY WALNES, OF TILLYANDTHEBUTTONS.COM

★ **MAKE A NO-SLIP FABRIC GRIP**

Are you trying to machine-sew a two particularly rambunctious piece of fabric together? Make: contributor Andrew Lewis offers this great tip. “Spray both sides of a piece of tissue paper with temporary fabric adhesive. This will help stop stretchy or slippery fabrics from moving while you sew them together. The needle cuts through the paper as it stitches, so you can just rip the paper away when you’re done.”

[AL]

TROUBLESHOOTING, MAINTENANCE, AND REPAIR

We live in a culture of obscene waste and mindless disposability. Most of us give little thought to maintaining the tools and machines we have if they get a little long in the tooth or stop working. One of the many positive developments that has grown out of the maker movement is a growing interest in repairing, maintaining, or repurposing the hardware in our lives. Part of the maker ethos is to know the technology in your life—to not be afraid to look under the hood of the machines you use and to understand how they work. Once you do, being able to troubleshoot, repair, and upgrade becomes far more achievable. What follows are a few miscellaneous tips related to troubleshooting, maintaining, and repairing your gear.

★ **FIND (OR START) A REPAIR CAFE**

A trend that is starting to spread worldwide, especially in Europe, is the emergence of repair cafes. These can be actual physical shops or regular events held at libraries, schools, churches, and other public places. Residents bring their broken appliances and consumer electronics, and instructors help them troubleshoot and hopefully repair their gear. Often, the exchange is free, donation-based, or requires only a small fee. Repaircafe.org maintains a global map of repair cafes. If you don't see one in your area, consider starting one. It's a great way to do something positive for your community, a way

to socialize with your neighbors, and a great way to help slow the endless bulldozing of waste into your local landfill.

★ **TROUBLESHOOTING OLD CIRCUIT BOARD GLUE**

In all of my years of monkeying with electronics and hacking hardware, I never in a million years thought that the glue used to secure components onto a circuit board could be a factor in circuit failure. But in a video on Mr. Carlson's Lab on YouTube, Mr. Carlson shows how, over time, the circuit board glue used in consumer electronics actually becomes conductive and should always be looked at along with any other components when you're trying to troubleshoot an old, dead circuit. He says that the darker the glue has turned, the more conductive (and therefore suspect) it is likely to be.

★ **MAINTAINING AN IRON**

Dirty irons can leave permanent marks and smudges on fabric and garments, and blocked steam vents can keep your iron from properly pressing, and that's definitely not ideal when you're in the middle of a project! To clean your iron, place two paper towels on your ironing board and then place an unused dryer sheet on one of them. Rub the hot iron over the dryer sheet for a few seconds and then over the other paper towel. Do this until your iron plate is clean. To clean out the steam vents, use cotton swabs and some distilled water (on a cool iron). When you're done, wipe down the entire plate with water and then dry. Done!

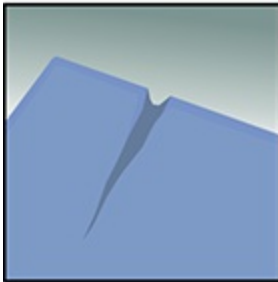
★ **CLEANING CHROME WITH ALUMINUM FOIL**

If you have some shabby-looking chrome with a little bit of

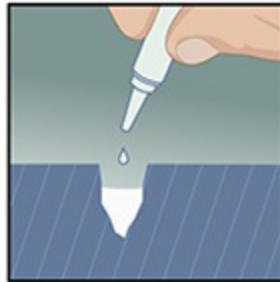
moderate pitting and rust, you can partially rejuvenate it with nothing more than a ball of aluminum foil and some water. Some people recommend Diet Coke instead of water. Others swear by vinegar. Experiment and see what works best for your application.

Tricks of the Trade

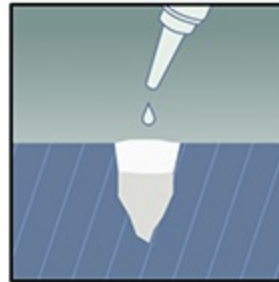
Tim Lillis (narwhalcreative.com)



Have an imperfection or crack in a plastic part? This trick from George Schnakenberg III has you covered.



Put a small amount of baking soda into the cavity. Drip some cyanoacrylate into the powder until saturated.



In deep cavities, you may want to build up layers of the mixture to make sure you're getting good coverage.



Sand or scrape away any excess glue and paint your part if you like. For best results, experiment on some scrap before working on your final part.

GRANDPA SHOWS THAT YOU CAN FIX, MODIFY, OR IMPROVE AN JUST ABOUT ANYTHING

When I was a child, I was at my grandpa's farm and wanted to pump up my bike tire, but his old hand pump wouldn't work. He took it apart and found that the cup-shaped rubber piston between two washers was dry rotted, cracked, and torn. He told me not to worry; he could fix it. My dad and I thought: "How can you fix a torn custom piece of rubber?" Grandpa found an old work shoe, and cut a circle from the leather. Next, he punched a hole in the middle, and then grabbed some petroleum jelly and worked it into the leather circle. Then, he put the circle between the washers and nut on the tire pump shaft, and got rid of the original rubber piece. As he worked the leather into a cup shape and fit it into the pump housing, he cut and trimmed the circle precisely, and got it to slide down into the pipe. Finally, he reassembled the pump unit, and it worked like new. Grandpa showed two younger generations at once that you can improvise and fix anything. I am not sure where that tire pump wound up after he passed away and his farm was sold, but I'm sure it still works to this day.

—CRAIG SMITH

SAFETY AND FIRST AID

“Safety third!” is an ongoing joke within the maker community. Many people are shocked when they encounter this phrase, thinking that it’s actually encouraging people to be reckless and unsafe. This can’t be further from the truth. First off: it’s a joke. It’s meant to be shocking and wrong, and to generate an uncomfortable laugh. But really, what it’s meant to do is to poke fun at our overly protective, safety-obsessed culture that places too much emphasis on safety, security, and protection, to the point where we’re all afraid to do anything for ourselves. The maker movement has given people permission to play, to try new things, to be willing to make mistakes, and to learn through trial and error. Similarly, funny statements like “Safety third!” are not trying to encourage cavalier behavior, but to remind people not to be so uptight about everything that could possibly go wrong that they never do anything. Almost all types of Making in the physical world, using any type of moving machinery, chemicals, and building materials, carry dangers and risks. The key is to be as well informed as you can be about what those risks are, to know how to prevent them from happening, and to know what to do in the event of something going wrong. Here are a few basic tips you might find useful.

★ REHEARSE YOUR TOOL USE

Before you turn on and use any cutting, drilling, pressing, or other powered tool that moves and can possibly harm you because of that motion, it’s a good idea to walk through the

steps that you are about to take. Make sure the height of your chair works with the job, that no cords are in the way, and that your clamps and jigs are all positioned and tightened properly. Make sure that your hair and clothes are tucked safely away. And as you work, think about what you are doing and what you need to do to stay safe as you move through the steps of your job.

★ SUPER GLUE STITCHES

Craig Smith writes, “For cuts that are deep, but that don’t require stitches, or in an area where stitches are tricky, Super Glue (cyanoacrylate) can be used (the American Medical Association even recognizes it as a medical aid!). Gently clean the wound with antibacterial soap, rinse, and dry. Place a drop of glue on a piece of plastic (paper will absorb it), hold the wound closed, dip a toothpick in the glue, and drag a bit across the cut. Two or three ‘stitches’ across the cut will do the job. Do not go along the cut. And do not totally seal the cut. Amazingly, heal time is only a day or two. And the best part is that you can go back to your project almost immediately after your boo-boo is properly glued up.” [CS]

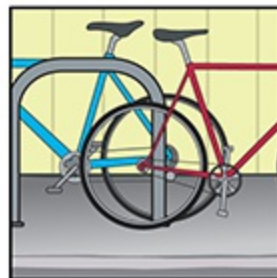
Tricks of the Trade

Tim Lillis (narwhalcreative.com)

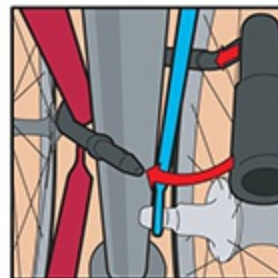
One small lock and two bikes? No problem!



Stuck with two bikes and one lock? And it's a mini-lock? Fear not, this trick from Ethan Clarke has you covered



First, arrange the bikes at a suitable lock post facing opposite directions with the rear axles as close as possible to the post slightly overlapping the rear triangles.



Next, near the dropouts, where the seat stay and chain stay meet, thread the lock through. Make sure to go through both rear triangles and go around the post.



Don't forget that unless you have cables or locking skewers, your wheels are still vulnerable, so use this as a last resort or combined with other techniques.

★ **REMEMBER MEDS IN YOUR FIRST AID KIT**

Dr. Caroline Lewis, wife of Make: contributor Andrew Lewis, is a specialist trauma care doctor in the U.K. I asked her to share a few maker-friendly first aid tips. She writes, “Always remember to not only keep your first aid kit stocked with the usual over-the-counter drugs (ibuprofen, paracetamol/acetaminophen, antihistamine, and so on), but also some of your prescription medications, if you take any. This can help if you ever run out unexpectedly.” Many good first aid kits actually come with a couple of empty bottles expressly for this purpose. [CL]

★ **MAKING A SAFETY PIN SLING**

If you need a sling to immobilize an arm but don’t have anything suitable to make one, you can use safety pins to fix the cuff of the shirt to the chest of the shirt until you can find something better. Use several pins if you have them, and make sure to gather as much fabric as possible onto the pins to prevent the weight of the arm from tearing the fabric. [CL]

★ **KEEP A RAZOR IN YOUR FIRST AID KIT (AND A PAIR OF GOOD SCISSORS)**

Dr. Lewis: “Most people think to include scissors in their first aid kit, but not many think of putting in a disposable razor, too. Shaving around an affected area can help bandages and wound-closing strips stick to skin, especially if you’re particularly hairy.” And make sure the scissors in your kit are a good pair of trauma shears. Not only might they be used for cutting bandages, but they may also be called on to cut through clothing and the like. [CL]

👉 **WORKING WITH ELECTRONICS: 5 SAFETY**

TIPS FOR KIDS

Parents fear the day when children outgrow the desire to use their LEGO blocks to build and create. That's because what often follows is their offspring's pleas for tool and electronic kits.

Nothing instills dread into a caregiver like the thought of poked eyes, smashed fingers, and potential electrocution resulting from DIY projects. Of course, most parents cautiously weigh the pleasure and satisfaction that accompanies their child producing a mechanical, electrical, architectural, or usable piece of work against the risk that comes along with crafting it.

The good news is that tool and electronics kits can be very safe resources. Here are five safety tips for parents to consider before and after buying a kit.

1. Determine your child's level of interest.

A child who's fascinated by tools or electrical equipment typically demonstrates an almost obsessive interest in them, pays attention, takes direction well, and instinctively focuses on the job at hand. I've taught soldering to children as young as eight, and their ability to concentrate is astonishing.

If you're a DIY enthusiast with a basement tool-and-gadget area, let your child see the fruits of working with these objects, and identify with what Mom or Dad does to fix or make things. If you sense your child's delight in imagining similar creative endeavors, then buying a kit could be a good idea.

2. Evaluate your child's dexterity.

Before buying a kit, make sure your child can identify and handle simple tools, nails, and screws. One way is to take a piece of soft wood, like pine, and let your child softly hammer thumbtacks or short nails with large heads into it, or insert

screws into premade holes. Ask your child to bend a paperclip with your pliers. Determining your child's strength and control is critical.

Think in terms of getting your child "qualified" to use tools. Start off with hand tools—those powered solely by hand and not reliant on batteries or electricity like hammers, screwdrivers, and pliers. After your child masters using simple tools, you may proceed to battery-operated ones.

3. Know your kits.

Commercially available tool kits may contain tools that are too heavy for your child. If this is the case, then consider customizing a tool kit by purchasing a smaller hammer or other items separately.

Since electronic tool kits contain items that are powered by electricity, it's essential that you confirm your child is a whiz at using battery-operated tools before you graduate to those that get plugged into sockets.

4. Be dramatic.

At the beginning of my soldering classes, I give my young students a short, but scary, warning. I point out which end of the soldering iron to hold, and explain that the other end is hot enough to melt metal, burn skin, and cause pain. Clearly state the consequences of careless behavior, which includes putting fingers or other objects into sockets.

5. Schedule supervisory time.

When children operate electrical tools, they must never be left alone. This means you need to allot time to evaluate their skills, conduct practice sessions (like hammering a few hundred nails into wood), and supervise them as they do projects you assign or those contained in project kits. One great beginner project allows them to create a small music

synthesizer, which involves lots of soldering of knobs and small components.

When determining whether tool and electronic kits are in your child's future, it's instructive to think about how the army approaches use of weaponry. You don't get to pick up a bazooka on day one. You first get a shovel and become a master at digging holes. Let your child start at the most basic level and ascend through the tool-and-electronic ranks. [DW]

The above is an excerpt from Dale Wheat's Building Your Own Electronics Lab: A Guide to Setting Up Your Own Gadget Workshop (Apress, 2012).

21

MISCELLANEOUS

As I began sorting all of the tips I gathered, I came across ones that I knew I wanted to include, but they didn't seem to fit into any category. Little did I know they would fit perfectly . . . into a chapter called "Miscellaneous." Fancy that!

★ ENCOURAGING OTHERS

In a makers group on Facebook, maker madman Izzy Swan posted a challenge for everyone: Reach out to other makers, one a day, to offer them encouragement and praise. I love stuff like this. Even when we don't care to admit it, I believe we all crave high fives, pats on the back, and shiny gold stars on our homework. Sure, we spend half our days thumbing the Likes on social media until our actual thumbs hurt. And while that may give us all a tiny little ego-tickle (in a rat-in-a-maze, press-bar-get-treat kind of way), nothing beats genuine heartfelt praise, thoughtful nudging, and the showing of some earnest admiration and love. And yes, it can be a little awkward sometimes to express the warm and fuzzy, and even hard to receive positive feedback and praise. Get over it! The world could use a few pats on the back right now. Make someone's day. Tell them how and why they inspire you. **[IS]**

★ PICK UP THINGS WITH A DART GUN

Need something to pick up small and flat objects and parts? Try using the suction cup from a toy dart. **[NDB]**

★ GET THEE A “CRAFT MAT”!

For too long, I took the “self-healing” billing of my cutting mat far too literally, subjecting it to paints, glues, epoxies, clay, heat, and all sorts of other indignities from which it does not heal. My decades-old cutting mat looks like the surface of the moon. Besides cutting, every other crafting, hobby, or art activity should happen on some other surface, and that surface for me is a heavy-duty PTFE (Teflon) sheet. These sheets are branded as “craft mats,” and sold for as much as US\$18 for a 15” × 18” sheet. But if you search for “PTFE Teflon sheet” at your favorite e-tailer, you can get a box of five 16” × 24” sheets for only US\$10. These Teflon sheets first seem rather fragile and insubstantial, but they’re virtually indestructible. Almost nothing sticks to them. And besides the mat acting as a protective surface, you can also use it for techniques like low-brow paper marbling (mix some paints on the sheet and swirl paper through it). To clean the sheet, you simply wipe with a rag—good as new.

★ EMPLOYING MAGNETS AROUND THE SHOP

YouTube maker Tim Sway shared this tip in one of his videos. Tim does a lot of upcycled woodworking and other reuse projects. When tearing down old speakers and stereo equipment, he keeps all of the speaker magnets and places some of them around his shop to become magnetic tool holders. He even leaves some in their conical metal housings to become magnetized bowls into which he can toss metal tools and objects. [TS2]

★ USING MAGNETS AS METAL DETECTORS

Tim Sway also uses a magnet as a nail and staple detector for scanning recycled lumber before cutting or planing. He also

shares another great tip: instead of keeping all of your hammers in one drawer, drivers in another, and so on, keep sets of these basic tools stashed all over the shop, near the stations where you use them. [TS]

Tricks of the Trade

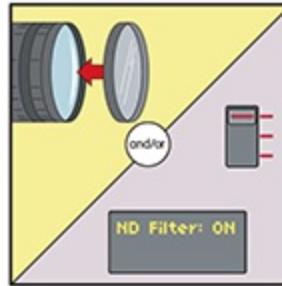
Tim Lillis (narwhalcreative.com)



Need to shoot an interior shot during the day but want it to look like a night shot? Try this trick from George Cox at lovethewoods.com.



First, set up a light close to your subject. Don't worry about blocking out the windows.



Next, depending on your camera, either attach a neutral density filter to the lens, or enable the in-camera ND filter. You may want to use both.



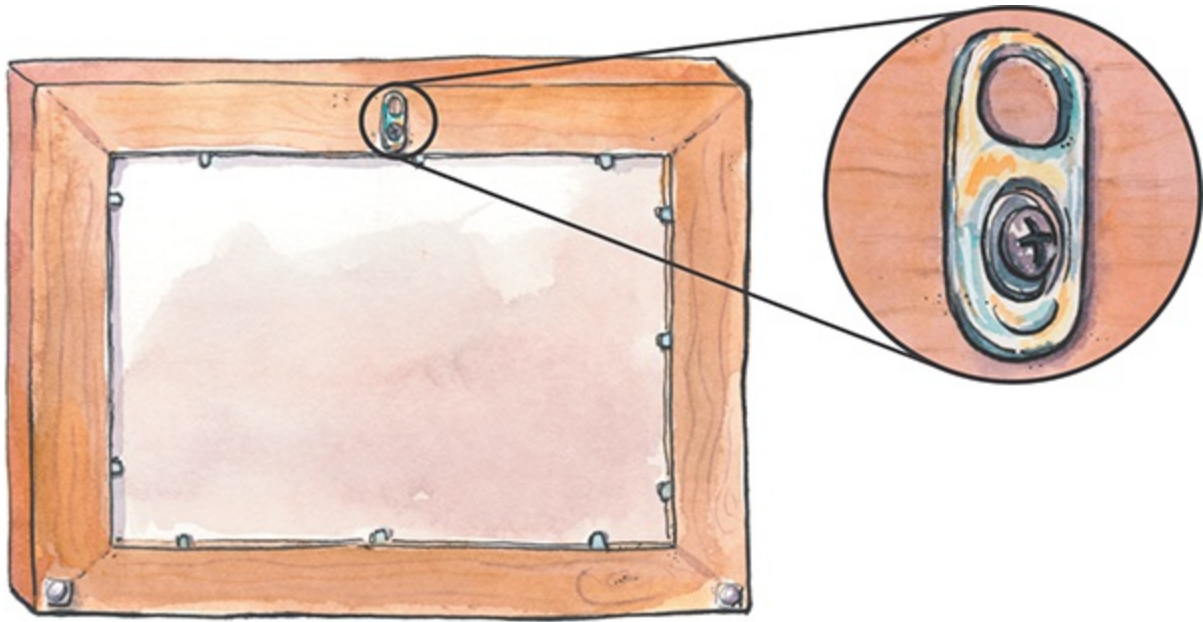
Enjoy your quick and easy day-for-night shot and avoid messing around in post-production. For best results, experiment with your camera's ND filter settings.

★ FIND GREAT TOOLS AT AN ESTATE SALE

Estate sales are a great place to find quality tools (often vintage) and materials at very affordable prices. [HITD]

★ HANGING PICTURES THE POOR MAN'S WAY

Need to hang a picture but don't have proper hardware? Use a beer or soda pull tab or two as your hooks.



★ **FILL SCREW HOLES WITH MATCHSTICKS**

You've likely seen this little hack before (a Pinterest favorite), but it's worth mentioning in case you haven't. The idea is simple: to fix loose screw holes, jam a matchstick into the hole and then re-sink the screw. You can use wooden matches or toothpicks, and use multiples as needed. You can even add some wood glue (especially if it's a hole that requires more than one sliver of wood).

★ **FABRICATE POUR SPOUTS FOR THE SHOP**

Save the tops of cardboard salt boxes (the type that have a recloseable spout). You can cut them out and use them inside the metal rings of canning jars to create reusable pour spouts.

★ **FASHIONING A TOOL FOR PRYING OPEN CONSUMER ELECTRONICS**

Using screwdrivers and other metal tools to open the case on

a piece of consumer electronics will quickly mar and scratch its surface. If you need to pry open a case, cut a defunct credit, rewards, or gift card at a 45-degree angle to create a more forgiving opening tool.

★ USING THE GRAPHITE TRANSFER METHOD

If you need to transfer an image but don't have any sort of typical transfer media, simply rub the graphite from your pencil onto one side of a piece of paper to create one. Flip the paper over onto your workpiece, draw your image while pressing down fairly hard, and the graphite on the underside of the paper will transfer onto the workpiece. [JD]

Tricks of the Trade

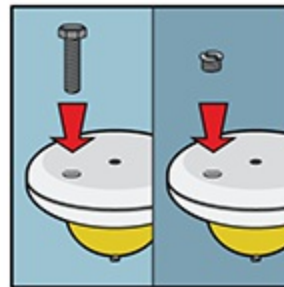
Tim Lillis (narwhalcreative.com)



Looking to take a time-lapse panorama? Larry Towe of getawaymoments.com has a clever and inexpensive solution!



He used an IKEA kitchen timer, but this trick is adaptable to many timers. Drill a 15/64" hole in the center of the top and insert a 1" 1/4"-20 set screw.



On the bottom, drill an 11/32" hole and insert a 3/8"-16 to 1/4"-20 bushing. You may need to tap (add threads to) the hole using a 3/8"-16 bolt.



Now you can mount the camera on a tripod (or add some tool mat to the bottom of the timer for tabletop use). Wind up and click!

★ USING STEEL WEIGHTS IN THE SHOP

Big chunks of off-cut steel, in bricks, plates, or discs, make indispensable shop assistants. You can use them to hold workpieces down for cutting, gluing, dry-fitting, and more. You can buy commercial shop weights, but you can also get them from any metal supply place or your friendly neighborhood machine shop. These shops usually have off-cut pieces they will gladly sell you or, if they're really friendly, even give you for free. [JD]

★ GIVE OLD TOOLS AWAY

Want to make someone's day and make yourself feel good in the process? If you have old tools that you no longer need, give them away. Give them to a school, library, homeless shelter, or a local makerspace. Or give them to a friend or neighbor who needs them. As Jimmy DiResta said in one of his vlogs on YouTube, it's a great way to give back, to make new friends, and to lighten your load. And trust me, it will make you feel good to do so. [JD]

Tricks of the Trade

Tim Lillis (narwhalcreative.com)



Don't ever lose a beer to gravity again! Use this trip from my friend at the corner store to keep your 6-pack from poking holes in your plastic bag.



Firmly grab the 6-pack and squish a corner on the counter, floor, table, or other hard surface.



Squish the rest of the corners and place the 6-pack in a bag. This also works with paper bags and with helping to fit it in a backpack.



Head to the BBQ with confidence that all your beers will remain intact!

★ DIGGING HOLES WITH A SHOP VAC

You may never have thought of this, but Jake von Slatt excitedly posted a little video on his Instagram account when he realized that you could actually use a powerful shop vac to effectively dig post holes. Who knew? [JVS]

★ USING WOOD GLUE FOR SCREEN PRINTING

German maker Laura Kampf shared this tip in one of her YouTube videos ("Laura's Emergency Screen Printing"). Instead of using photo emulsion to create a stencil for screen printing, she uses wood glue. As she points out, it's not perfect, and

you can't really reuse the screen, but for a quick screen printing job, it does the trick.

★ FIND TREASURES WITH THE “GRANDFATHER’S” SEARCH TERM

James Wright of the YouTube channel Wood by Wright shared this clever tip for searching for wood on Craigslist. He set up a search string notification for “grandfather’s” (possessive). That way, things like “I’m cleaning out my grandfather’s workshop” will get messaged to him. Years ago, this notification returned: “I’ve purchased my grandfather’s barn and now I need to clear out all of the lumber. I’m selling it all for US\$0.50 a board foot.” James went to check it out and it turned out to be 20,000 feet of white oak, air dried for 15 years. He bought as much as he could cram into his van and he’s still pulling from that stock today. As he points out, this search term will also help you scoop up tools and other great, granddaddy goodness. This reminds me of a similar tip I used years ago to get some amazing deals on eBay: search on misspellings of your desired items. Those listings get far less traffic due to the spelling error. [JW]

Tricks of the Trade

Tim Lillis (narwhalcreative.com)



Trying to find true north but don't have a compass? Don't worry, as long as you know the time you can find your way.



This trick works on a watch if you have one, but if you don't you can draw a clock face in the dirt or on some paper. Draw a circle, and within that, an hour hand pointing toward the sun.



Mark the current time where you drew your hour hand. Based on that, figure out where 12 would be and draw that in. If it's currently daylight savings (in the US, Mar-Nov) use 1 instead of 12.



Bisect the angle between the current time and 12 and draw another line. North will be on the far side of that line from the sun as long as you are in the non-tropical Northern Hemisphere.

★ **CREATE A FREEZER POWER-LOSS INDICATOR**

To help determine whether your freezer thawed (or partially thawed) during a power outage, try this little trick. Freeze a cup of water, place a quarter on it, and place it in the freezer. After the storm, when the power is restored, check the cup. If the quarter is unmoved, the freezer is safe. If the quarter is partially submerged, you had some thawing, but the freezer contents may still be safe. If the quarter is at the bottom, you had a significant failure and the contents of your freezer are likely spoiled. I plan to just keep such a cup in the freezer from now on. And, by the way, if you do end up with a fridge or freezer full of spoiled food, check your homeowner's insurance policy. Spoiled food is usually covered (if it's not the result of flooding).

★ **DEVISE SOME POOR MAKER'S SHRINK FILM PLASTIC**

On an episode of Barb Makes Things, she shared something I was unaware of about how to use plastic shrink film. You can use Type 6 plastic (common in food packaging) as shrink film. It's not quite as uniform and consistent as commercial shrink film, but for many applications, it should be just fine. She has some other great tips in her video, like sanding the plastic to get a frosted effect (and to hold more marker pigment) and using baking parchment on the heating tray to allow you to quickly swap out pieces you're heating from the oven (and to prevent sticking). [\[BN\]](#)

★ **PHOTO-DOCUMENT PROJECTS IN REVERSE**

Make: contributor and technical writer James Floyd Kelly

shares this trick, which I have also used, for documenting a project build: “While taking apart an item, I shoot a photo of each step. If I remove a screw, I take a photo. If I take spring slides off a pin, I take a photo. Once the object is fully disassembled, you simply have to reverse the order of the photos and you have a visual representation of how to put the thing back together. And it helps to make sure you write the steps accurately, because every step has been visually documented.” [\[JFK\]](#)

BASIC MAKER SKILLS FOR KIDS

A list of baseline skills in the Maker Curriculum that all well-prepared kids should be versed in before they reach adulthood. Think of it as home-schooling in self-reliance.

Maker kids should know how to:

- Use basic scientific and critical thinking
- Perform CPR and general first aid
- Tie basic knots
- Swim
- Ride and fix a bike
- Solder and understand basic electronics
- Change a tire and oil, jumpstart a car, and change the air filter
- Generally understand combustion engines
- Cook the basics and understand food safety
- Use a fire extinguisher
- Set up a tent, build a lean-to, and collect and purify water
- Navigate with a map and compass
- Understand basic conditional logic in computer programming
- Use basic sewing techniques, including straight and whipstitch

- Safely handle fireworks, explosives, and propellants
- Fix and replace basic components in a toilet tank and shut off the water supply
- Safely handle power tools and sharpen tools and knives
- Practice basic electrical safety
- Understand house (AC) electrical systems and know where the breaker is and how to reset it
- Build a fire (Bonus points: without matches or a lighter)

Adapted from an original “Basic Self-Reliance” post by Stefan Antonowicz. See the original post and discussion at makezine.com/go/curriculum.

CONTINUING THE CONVERSATION

his book is really a captured conversation. In my work with Make:, my regular “Tips of the Week” column on the Make: website, and in my overall job as an encyclopedist of all things DIY, I root out tips as I hear them and as people share them with me. I also come up with some of my own and send them back in the other direction. So, let’s talk. If you have a tip, or a favored tool or technique for any manner of makery, I’d love to hear about it. If you have stories that go along with your tips and tools, I’d love to hear those, too. Your tips and tales may end up in a column of mine or in a future edition of this book. You can email me at garethb2@gmail.com.

INDEX

Numbers

3D designing, tracing photos of objects, [150](#)

3D printing

bed adhesive, [149](#)

digital fabrication, [155](#)

low res, [150](#)

parts from McMaster-Carr, [154](#)

test prints, [153](#)

texture of print layers, [153](#)

tips, [148–149](#)

water transfer film, [153](#)

3D prints

adding patterns, [153](#)

finishing, [153](#)

A

acetate overlays, using in notebooks, [26](#)

acrylic drilling, water cooling, [92](#). See also drilling

acrylic paint, thinning, [139](#)

aged brass look, applying, [128](#)

agitator balls, adding to paint, [138](#)

Akiba Wang, Chris, [29](#)

alligator clips, declawing, [113](#)

aluminum alloys, [33](#)

aluminum foil

cleaning chrome, [165](#)

lining paint trays, [132](#)

masking with, [132](#)

Amamoto, Ken, [64](#)

angling bins, [15](#)

anticipating next steps, [31](#)

Antonowicz, Stefan, [182](#)

Argaiv, Antron, [116](#)

assumptions, avoiding, [34](#)

attire for makers, [28](#)

auction buying notes, [104](#)

awl, [92](#)

B

baking soda, using in glue, [78](#)

Balloondoggle, [39](#)

bar clamps, extending, [68](#). See also clamps

Barb Makes Things, [180](#)

Barnes, Kent, [5](#)

Bates, Jay, [3](#)

battery organizer, [5](#)

beer 6-packs, protecting, [178](#)

“Beginning Engineer’s Checklist,” [28](#)

Bell, Donald

cable weaving with zip ties, [14–15](#)

- Casio Rapman keyboard, [16](#)
- solder points, finishing, [114](#)
- The Ben Heck Show, [27](#)
- best practices, [53-54](#), [78](#). See also tips
- Big Gulp Syndrome, avoiding, [103-104](#)
- bike lock, two bikes, [169](#)
- bike tire, fixing with hand pump, [166](#)
- binder clips
 - as helping hands, [115](#)
 - organizing with, [3](#)
- Bird by Bird, [21](#)
- Birkey, Andy
 - measuring multi-part epoxies, [45](#)
 - pre-making mistakes, [18-19](#)
 - reducing nail gun pressure, [99](#)
- black hot glue, using as light sealant, [108](#)
- blades
 - dullness, [57](#)
 - keychain strop, [143](#)
- Boardman, Lindsey, [39](#)
- bonding plastic pieces, [72](#). See also gluing
- BonzoGog1, [138](#)
- brainstorming, [32](#)
- brass look, applying, [128](#)
- bread tags, using to label cables, [7](#)

brush cleaning rack, creating, [134–135](#)
brush tips, re-pointing, [130](#). See also paintbrushes
build early/build often, [22](#)
building, best practices, [25](#), [28](#)
bulletin board, making, [10](#)
Bulloff, Libby, [18](#), [39](#)
Bunker, Jordan, [136](#)

C

CA (cyanoacrylate) glue
 lubricating caps, [79](#)
 using as gap filler, [78](#)
 using on cuts, [168](#)
cable splice, making, [118](#)
cables
 identifying, [7](#)
 labeling with bread tags, [7](#)
 organizing, [8](#), [12–13](#)
 standing off, [14](#)
 weaving with zip ties, [14–15](#)
canned air, using to break glue, [78](#)
carpenter square, finding center of circle, [43](#)
Casio Rapman keyboard, [16](#)
casting and molding, [119–123](#)
caulking gun, using as clamp, [67](#)
CD spindles, organizing cables, [13](#)

center, finding, [42–43](#)

chalkboard, making, [10](#)

checklist for makers, [28](#)

children, safety tips, [170–172](#)

chloroform solvent, [120](#)

chrome, cleaning with aluminum foil, [165](#)

circle, finding center, [43](#)

circuit board glue, troubleshooting, [164](#). See also glue

Clagett, Bob

 pocket notebooks, [12](#)

 sanding grips, [126](#)

 spinning shop organizer, [15](#)

clamping jig, creating, [81](#)

clamps. See also bar clamps

 as caulking guns, [68](#)

 caulking guns as, [67](#)

 creating with PVC, [66](#)

 driving nails, [66](#)

 hot glue, [81](#)

 leather pads, [68](#)

 speed handling, [67](#)

Clarke, Ethan, [169](#)

cleanup, including in job estimates, [25](#)

climbing out, using, [60](#)

clocks, repairing, [97](#)

closing gaps, [75](#)

CNC (computer numerical control) routers

 saving laptop, [154](#)

 workholding, [154-155](#)

CNC prints, skipping tabs, [155](#)

CNC router bits, inspecting, [154](#)

color-coding screwdrivers, [6](#)

compass-cutter, hobby-knife, [60](#)

component-lead tools, using, [105-106](#)

concepts, sketching, [29](#)

Conner Tanguay, Sara, [155](#)

containment boxes, making, [126](#)

Cool Tools website, [2](#)

copper pipe, small-diameter, [60](#)

cords, managing, [13](#)

Cox, George, [175](#)

“craft mats,” using, [174-175](#)

Crane, Mark, [39](#)

Cullum, Len, [145](#)

cut piece, holding up, [63](#)

cuts, fixing with Super Glue stitches, [168](#)

cutting

 bendable join in wood, [57](#)

 clearing metal scribing, [61](#)

 climbing out, [60](#)

hacksaw, [61](#)
hand sawing, [57](#)
hobby-knife compass-cutter, [60](#)
listening to tools, [60](#)
PCB fiberglass, [102](#)
pipe with string, [62](#)
polyurethane foam, [63](#)
retractable pocket saw blade, [58](#)
rip and flip, [56](#)
router protection, [60](#)
scoring and breaking foamboard, [63](#)
shortening bolts, [61](#)
small-diameter copper pipe, [60](#)
square of saw, [61](#)
straightedge table saw, [56](#)
table saw blade, [57](#)
tape for preventing tear-out, [63](#)
cutting jig, building, [58](#)
cutting mats, using craft mats, [174-175](#)

D

darning holes, [158-159](#)
dart gun, using to pick up things, [174](#)
day for night, photography, [175](#)
de Vinck, Marc, [122](#)
dead space, using, [3](#)

Deagan, Tim, [156](#)

dents in wood, getting rid of, [127](#)

designing for disassembly, [28](#)

desoldering, [113](#)

Devaney, Kevin, [39](#)

diamond cut, speed square, [49](#)

die-cutting/stencil-making machines, [155](#)

digital scale

- keeping clean, [121](#)

- multi-part epoxies, [45](#)

DiResta, Jimmy

- DuPont power hammer, [31](#)

- proud joints, [74](#)

- shop counterweight, [75](#)

- using new machines, [22](#)

Dirt Farmer Jay, [13](#)

documentation, [28](#), [181](#)

drawing

- lines, [41-42](#)

- pictures, [69](#)

- stitching lines on fabric, [160](#)

drawing concepts, [29](#)

drawing isometrically, [23-24](#)

drill

- taping level to, [88](#)

- wooden drilling guide, [88](#)
- drill bits
 - keeping steady, [91](#)
 - sharpening, [143-144](#)
- drill depth, marking, [88](#)
- drill dust, catching, [89-90](#)
- drill press chuck, saving, [89](#)
- drilling. See also acrylic drilling; holes
 - CD used for holes, [91](#)
 - holes, [90](#)
 - nail as pilot hole bit, [91](#)
 - punching before, [91](#)
- DSCOTTHEP, [39](#)
- duct tape vs. WD-40, [74](#)
- due diligence, [18](#)
- dull blades, working with, [57](#)
- DuPont power hammer, [31](#)
- Durant, Megan, [39](#)

E

- eBay, buying electronic components, [103-104](#)
- edges, marking as not true, [53](#)
- electric knife, cutting polyurethane foam, [63](#). See also knives
- electronic components, buying on eBay, [103-104](#)
- electronics, prying open, [177](#)
- electronics insulator, hot glue, [83](#)

electronics tweezers, using, [106](#)

encouragement, providing, [174](#)

epoxies, working with, [120](#)

epoxy putty, rolling in flour, [122](#)

equipment, storing, [10](#)

equipment dead space, using, [3](#)

Evil Mad Scientist Labs, [106](#)

F

fabric

- drawing stitching lines, [160](#)

- holding in place, [161](#)

fabric grip, no-slip, [162](#)

fabric paint, making, [133](#). See also paint

Family Handyman, [61](#)

fasteners and screws, organizing, [4](#)

fastening. See also screws

- holding screws in place, [96](#)

- rubber band on stripped screw, [94](#)

- uses for poster putty, [95](#)

Ferry, Nick, [41](#)

Feynman technique, learning with, [18](#)

first aid, [28](#)

first aid kit

- meds, [169](#)

- razors, [170](#)

first order retrievability, [2](#)
Fizenberger, Pat, [39](#)
flea market, brainstorming at, [32](#)
foamboard
 scoring and breaking, [63](#)
 sealing edges, [84](#)
“Frankenstein prototyping,” [20](#)
freezer power-loss indicator, [180](#)
friction welding, [72](#)
fridge magnet battery organizer, [5](#)
Frishman, Bob, [97](#)
furniture, painting, [130](#)

G

gap filler, using, [78](#)
gaps, closing, [75](#)
gloves, using with touchscreens, [160](#)
glue. See also circuit board glue; hot glue
 needle bottles and capillary action, [85](#)
 scooping up squeeze-out, [84](#)
 spreading with threaded rod, [79](#)
 squeeze tubes, [79](#)
 water-resistant mixture, [85](#)
glue strings, getting rid of, [79](#)
gluing. See also bonding plastic pieces
 around metal, [80](#)

- best practices, [78](#)
- breaking with canned air, [78](#)
- gap fillers, [78](#)
- and prefinishing, [80](#)
- preventing board traveling, [80](#)
- shaving at “gel” stage, [80](#)
- solvent cement, [82](#)

Godin, Seth, [2](#)

Gould, Richard, [31](#), [39](#)

grandfathers

- Five Little Notches, [30](#)

- Maker of Magic, [30](#)

- as search term, [179–180](#)

graphite transfer, [177](#)

gratitude loop, [2](#)

grips, creating, [8](#). See also sanding grips

H

hacksaw, getting into tight space, [61](#)

hammer

- closing gaps, [75](#)

- substituting, [76](#)

hammer handle, tape-dispensing, [72](#)

hand awl, [92](#)

hand sawing with orbital stroke, [57](#)

Hart, Alden, [39](#)

“hassle tax,” [17](#)

header pins, holding straight, [114](#)

heat-seal organizer, [10](#)

Heck, Ben, [27](#)

helping hands, [115–116](#)

Helsinki bus station theory of creativity, [22–23](#)

Hershberger, Ross, [107](#)

Hoefer, Steve, [160](#)

holding down workpieces, [177–178](#)

holes. See also drilling; pass-through holes

darning, [158–159](#)

digging with Shop Vac, [178](#)

drilling, [90](#)

Hollar, Kelly, [39](#)

hot glue. See also glue

bonding sticks, [83](#)

combining with PVA glue, [82](#)

debonding with alcohol, [79](#)

electronics insulator, [83](#)

healing burns, [81](#)

as light sealant, [108](#)

molds, [83](#)

prototyping, [82](#)

sealant, [83](#)

sealing edges of foamcore, [84](#)

using as clamp, [81](#)

Hrynkiw, Dave

arranging tools, [7](#)

cutting small-diameter copper pipe, [60](#)

hydrographic film, [153](#)

I

images, transferring, [177](#)

Ippolito, Frank, [121](#)

irons, maintaining, [165](#)

isometric perspective, drawing in, [23-24](#)

J

Jackman, Paul, [75](#)

job estimates, including cleanup, [25](#)

joining. See also tape

 bonding plastic pieces, [72](#)

 closing gaps, [75](#)

 folding tape, [72](#)

 friction welding, [72](#)

 tape-dispensing hammer handle, [72](#)

joints, making proud, [74](#)

K

Kalaxy, [39](#), [54](#)

Kampf, Laura, [137](#), [179](#)

Kaye, Perry, [20](#)

Kelly, James Floyd, [137](#), [181](#)

Kenny Rogers rule, [19](#), [28](#)

Ken's punch, [64](#)

keychain strop, making for blades, [143](#)

kids

- basic maker skills, [181](#)–[182](#)

- safety tips, [170](#)–[172](#)

Knetzger, Bob, [64](#), [98](#)

knives, testing edges, [142](#)–[143](#). See also electric knife

knobs, casting, [122](#)

Kraft, Caleb, [6](#)

Kramer, Bob, [142](#)

L

Lamott, Anne, [21](#)

laser engraving, color tinting, [156](#)

learning

- best practices, [53](#)–[54](#)

- Feynman technique, [18](#)

- wading into, [31](#)

leatherworking, high-tech, [156](#)

LEGO bricks

- mold boxes, [121](#)

- organizing, [9](#)

level

- taping to drill, [88](#)

using speed square as, [49](#)

Lewis, Andrew, [67](#), [169](#)

Lewis, Carolyn, [169-170](#)

light sealant, black hot glue, [108](#)

Lillis, Tim

aged brass look, [128](#)

bike lock, [169](#)

cutting small-diameter copper pipe, [60](#)

day for night photography, [175](#)

gloves and touchscreens, [160](#)

grips, [8](#)

organizing cables, [12](#)

organizing LEGO bricks, [9](#)

part multiples, [122](#)

protecting beer 6-packs, [178](#)

time-lapse panorama, [177](#)

true north without compass, [179](#)

vise/clamp with heat sink properties, [67](#)

voltage ratings for motors, [102](#)

lines

bringing off pages, [59](#)

drawing, [41-42](#)

scribing with tape measure, [40](#)

X-Acto knife, [59](#)

Livolsi, Bill, [4-5](#)

lubricant, pencil as, [96](#)

M

machine shop, considering hiring, [32-34](#)

magnets

for locating pass-through holes, [9](#)

using, [175](#)

magnification, using with PCB work, [105](#)

maker's checklist, [28](#)

makezine, maker's checklist discussion, [28](#)

manufacturing process, understanding, [33](#)

markers, using, [52](#)

marking tools

adding to tape measures, [42](#)

razors, [52](#)

speed squares, [46](#)

using, [6](#)

markings, painting over, [52](#)

marks, scratching with tape measure, [38](#)

masks, poster putty, [95](#)

matchsticks, filling screw holes, [176](#)

materials

ordering, [24](#)

specifying for machine shops, [33](#)

storing, [10](#)

matte glaze medium, making, [139](#)

measuring. See also speed square; tape measure

body parts, [36](#)

and designing, [69](#)

distance with thumb, [37](#)

hook slot on tape measure, [38](#)

long distances, [45](#)

multi-part epoxies, [45](#)

notepad on tape measure, [37](#)

itches, [48](#)

sky angles, [36-37](#)

speed square, [47](#)

sticks, [41](#)

measuring tape, using as notepad, [37-38](#)

meds, keeping in first aid kit, [169](#)

Meston, Geoff, [15](#)

metal detectors, magnets as, [175](#)

metal scribing, making clear, [61](#). See also scribe bar

mistakes, "pre-making," [18-19](#)

Miter square, speed square as, [46](#)

Modern Leatherworking, [156](#)

molding and casting, [119-123](#)

molds, creating with hot glue, [83](#)

motors, voltage ratings, [102](#)

MSDS (material safety data sheet), [82](#)

N

Nagy, Richard, [128](#)

nail grab, using to scribe lines, [40](#)

nail gun pressure, reducing, [99](#)

nails, driving with clamps, [66](#)

names of things, power in, [22](#)

NASA's Required Workmanship Standards, [117-118](#)

needle bottles and capillary action, [85](#)

needles

- changing, [160](#)

- rethreading, [161](#)

- threading, [158](#)

North, Doug, [97](#)

north, finding without compass, [179](#)

notebooks

- acetate overlays, [26](#)

- keyword index, [11](#)

- making, [12](#)

notepad on tape measure, [37-38](#)

O

orbital stroke, hand sawing, [57](#)

ordering materials, [24](#)

organization. See also planning

- binder clips, [3](#)

- cables, [12](#)

- cords, [13](#)

- fasteners and screws, [4](#)
- first order retrievability, [2](#)
- gratitude loop, [2](#)
- heat seal, [10](#)
- rituals, [2](#)
- see-through bins, [4](#)
- of shop, [4](#)
- straps, [9](#)

Orvar, Darbin, [68](#), [123](#)

Overstreet, Michael, [149](#)

Oxford, Jon, [76](#)

P

paint. See also fabric paint

- adding agitator balls, [138](#)
- avoiding contamination, [132](#)
- drain holes in cans, [132](#)
- thinning acrylics, [139](#)
- trimming rollers, [132](#)

paint and brush holder, making, [133](#)

paint cans, labeling bottoms, [134](#)

paint shield, using, [130](#)

paint stripper, solvent cement, [82](#)

paint trays, lining, [132](#)

paint washes, making, [138](#)

paintbrush, covering, [127](#)

painter's tape

low tack, [137](#)

using as template, [137](#)

painting

masking materials, [132](#)

masking off areas, [137](#)

raising up finishing work, [130](#)

reviving wood putty, [133](#)

paintbrushes, wiping off, [131](#). See also brush tips

Palmer, Chris, [23](#)

parts

buying surplus of, [25](#)

making multiples, [122](#)

paying for one-offs, [33](#)–[34](#)

replacing, [69](#)

sorting on sticky mat, [102](#)

storing, [10](#)

tracking, [4](#)

universe as collection of, [20](#)

pass-through holes, locating, [9](#). See also holes

PCB fiberglass, cutting, [102](#)

PCB work, using magnification, [105](#)

PCBs (printed circuit boards)

cleaning, [107](#)

depopulating, [113](#)

- enclosure, [29](#)
- pencil, using as lubricant, [96](#)
- pencil point, keeping sharp, [52-53](#)
- perfectionism, [2](#)
- photography, day for night, [175](#)
- picking up, using dart gun, [174](#)
- pictures, hanging, [176](#)
- pins, using for sewing, [158](#)
- pipe, cutting with string, [62](#)
- pitches, measuring, [48](#)
- pivot locator, [97](#)
- plane, flattening sole of, [144-145](#)
- planning. See also organization
 - learning, [23](#)
 - project enclosures, [29](#)
- plastic pieces, joining, [72](#)
- plastic shrink film, using, [180](#)
- Platt, Charles, [63](#)
- playing cards, using in shop, [41](#)
- Plumb, Andrew, [39](#), [69](#)
- pocket notebooks, making, [12](#)
- polycaprolactone, using, [120](#)
- polyurethane foam, cutting with electric knife, [63](#)
- Popular Woodworking, [57](#)
- poster putty, uses for, [95](#), [115](#)

pour spouts, fabricating, [176](#)

Price, Josh, [155](#)

printing. See 3D printing

project build, documenting, [181](#)

project enclosure, planning, [29](#)

projects, laying out on paper, [27](#)

prototyping tool, poster putty, [95](#)

protractor, speed square as, [46](#), [48](#)

PVA glue, combining with hot glue, [82](#)

PVC pipe

- bending with hot sand, [123](#)

- spray can holders, [15](#)

Q

Qi, Jie, [59](#)

quotes, providing, [25](#)

R

rafter square

- and carpenter square, [44](#)

- Common mark, [48](#)

- diamond cut, [49](#)

- features, [46](#)

- HIP-VAL mark, [48](#)

- as level, [49](#)

- manual, [50](#)

marking, [46](#)

measuring, [47](#)

measuring pitches, [48-49](#)

protracting, [48](#)

saw guide, [47](#)

scribe bar, [47](#)

Ragan, Sean, [39](#), [92](#)

razors

keeping in first aid kits, [170](#)

marking with, [52](#)

reed hook, [97](#)

repair cafe, finding or starting, [164](#)

retractable pocket saw blade, [58](#)

rip and flip, [56](#)

Roberts, Steven, [105-106](#)

Rogers, Kenny, [19](#), [28](#)

router protection, [60](#)

ruler, finding center of circle, [43-44](#)

"Rules for Roboticists," [19](#), [28](#)

S

safety

Super Glue stitches, [168](#)

tips for kids, [170-172](#)

tool use, [168](#)

safety glasses, using, [28](#)

safety pin sling, making, [169](#)

Sanders, Gary, [39](#)

sanding disks, storing, [127](#)

sanding grips, making, [126](#). See also grips

Savage, Adam, [2](#)

saw, checking square of, [61](#)

saw blade, retractable pocket, [58](#)

saw guide, speed square, [47](#)

“Sawdust Girl,” [52](#)

Scheff-King, Meredith, [154](#)

Schlegel, Reid, [29](#)

screen printing, wood glue, [179](#)

screw drivers, color-coding, [6](#)

screw holder, poster putty, [95](#)

screw holes, filling, [176](#)

screws. See also fastening; wood screws

holding in place, [96](#)

lubricating, [96](#)

organizing, [4](#)

taping slotted drivers, [98](#)

scribe bar, speed square, [47](#). See also metal scribing

scribe marks, making, [53](#)

sealant, hot glue, [83](#)

Seitz, David, [39](#)

sewing

- changing needles, [160](#)
- darning holes, [158–159](#)
- stitching lines on fabric, [160](#)
- threading needles, [158](#)
- using pins, [158](#)
- sewing machine mistakes, fixing, [161–162](#)
- ShapeLock plastic, using, [120](#)
- sharpening
 - angle, [142](#)
 - drill bits, [143–144](#)
 - flattening sole of planes, [144–145](#)
 - keychain strop, [143](#)
 - testing edges, [142–143](#)
- sharpening stone
 - ceramic mugs as, [143](#)
 - using soap, [143](#)
- Sharpies
 - metal scribing, [61](#)
 - using, [53](#)
- shop counterweight, improvising, [75](#)
- shop organizer, [15](#)
- shop scale, keeping clean, [121](#)
- Shop Vac, digging holes, [178](#)
- shrink film plastic, using, [180](#)
- sky angles, measuring, [36–37](#)

Slagle, Tim

eBay electronics buying tips, [104](#)

extra parts, [25](#)

small parts, tracking, [4](#)

Smith, Craig, [134](#), [166](#)

solder points, finishing, [114](#)

soldering

connection vs. strength, [116](#)

and desoldering, [113](#)

holding header pins straight, [114](#)

order of, [113](#)

sequence and timing, [110-112](#)

and splicing to NASA standards, [117-118](#)

tips, [117](#)

soldering iron, cleaning, [113](#)

soldering sponge, wetting, [113](#)

solvent cement, paint stripper, [82](#)

speed square

and carpenter square, [44](#)

Common mark, [48](#)

diamond cut, [49](#)

features, [46](#)

HIP-VAL mark, [48](#)

as level, [49](#)

manual, [50](#)

- marking, [46](#)
- measuring, [47](#)
- measuring pitches, [48-49](#)
- protracting, [48](#)
- saw guide, [47](#)
- scribe bar, [47](#)
- splicing and soldering, [117-118](#)
- spray can holders, creating, [15](#)
- spray paint
 - clearing nozzles, [137](#)
 - reviving cans, [135](#)
 - storing nozzles, [138](#)
 - techniques, [135-136](#)
- square of saw, checking, [61](#)
- squares, carpenter and speed, [43-44](#)
- stain brush, covering, [127](#)
- Stanley FatMax tape measures, [45](#)
- steel weights, using, [177-178](#)
- stencil-making machines, [155](#)
- Stern, Becky, [118](#)
- Stevens, David, [26](#), [39](#)
- stitching, making even, [161](#)
- stitching lines, drawing on fabric, [160](#)
- storage, heat-seal organizer, [10](#)
- straightedge table saw, using, [56](#)

straps, organizing, [9](#)
stretch wrap, organizing straps, [9](#)
strop, making for blades, [143](#)
Super Glue, using, [78](#), [168](#)
supplies, storing, [10](#)
surface roughness, specifying for machine shops, [33](#)
Swan, Izzy, [44](#), [174](#)
Swanson, Albert, [46](#), [49](#)
Sway, Tim, [175](#)

T

table saw blade, tightening, [57](#)
tape. See also joining
 folding for easy retrieval, [72](#)
 reducing adhesion, [74](#)
 tabbing for easy retrieval, [73–74](#)
tape measure. See also measuring
 adding marking tool, [42](#)
 end hook slot, [38](#)
 long distance measuring, [45](#)
 making hands free, [42](#)
 retrieving tools, [44](#)
 scratching marks, [38](#)
 serrated edge, [40](#)
Stanley FatMax, [45](#)
unassisted measuring, [38](#)

- zero hook feature, [40](#)
- tear-out, preventing with tape, [63](#)
- Tested.com, [121](#)
- test-fitting tool, poster putty, [95](#)
- thread, preventing knotting, [161](#)–[162](#)
- threading needles, [158](#)
- Tilden, Mark W., [102](#)
- time-lapse panorama, taking, [177](#)
- tips. See also best practices
 - 3D printing, [148](#)–[149](#)
 - from dads, [39](#)
 - Plumb, Andrew, [69](#)
 - safety for kids, [170](#)–[172](#)
- toilet paper tubes, organizing cables with, [8](#)
- tolerances, specifying for machine shops, [32](#)–[33](#)
- tool markings. See marking tools
- tool wall, laying out, [5](#)
- tools
 - arranging for easy retrieval, [7](#)
 - checklist, [28](#)
 - component-lead, [105](#)–[106](#)
 - finding at estate sales, [176](#)
 - giving away, [178](#)
 - hand awl, [92](#)
 - listening to, [60](#)

- marking, [6](#)
- pivot locator, [97](#)
- prying open electronics, [177](#)
- quality, [26](#)
- reed hook, [97](#)
- retrieving with tape measures, [44](#)
- using safely, [168](#)
- weaver's hook, [97](#)

Towe, Larry, [177](#)

transferring images, [177](#)

triangle square

- and carpenter square, [44](#)

- Common mark, [48](#)

- diamond cut, [49](#)

- features, [46](#)

- HIP-VAL mark, [48](#)

- as level, [49](#)

- manual, [50](#)

- marking, [46](#)

- measuring, [47](#)

- measuring pitches, [48-49](#)

- protracting, [48](#)

- saw guide, [47](#)

- scribe bar, [47](#)

Tricks of the Trade

aged brass look, [128](#)
beer 6-packs, [178](#)
bike locks, [169](#)
cutting copper pipe, [60](#)
gloves and touchscreens, [160](#)
grips, [8](#)
LEGO bricks, [9](#)
organizing cables, [12](#)
part multiples, [122](#)
shooting day for night, [175](#)
time-lapse panorama, [177](#)
true north without compass, [179](#)
vise/clamp with heat sink properties, [67](#)
voltage ratings for motors, [102](#)
true north, finding without compass, [179](#)
Try square, speed square as, [46](#)
tweezers, using, [106](#)

U

universe, collection of parts, [20](#)
ur-tip, [35](#)

V

Valenzuela, Miguel, [5](#)
vibration stabilizer, poster putty, [95](#)
von Slatt, Jake, [178](#)

W

Walker, Nick, [34](#)

Walnes, Tilly, [162](#)

washer, using with helping hands, [115](#)

water transfer film, [153](#)

water-resistant mixture, [85](#)

WD-40 vs. duct tape, [74](#)

weaver's hook, [97](#)

websites

 Cool Tools, [2](#)

 Evil Mad Scientist Labs, [106](#)

 first aid, [28](#)

 Lillis, Tim, [8](#)

 maker skills for kids, [181–182](#)

 maker's checklist, [28](#)

 safety glasses, [28](#)

 tools checklist, [28](#)

Wheat, Dale, [172](#)

wood, bendable join, [57](#)

wood, branding with ammonium chloride, [128](#)

wood dents, getting rid of, [127](#)

wood filler, masking around, [127](#)

wood glue, screen printing, [179](#)

wood putty, reviving, [133](#)

wood screws, starting, [98](#). See also screws

workholding, [154–155](#)

workpieces, holding down, [177–178](#)

wrenches, cheating, [98](#)

Wright, James, [179](#)

X

X-Acto knife, bringing line off pages, [59](#)

Z

zero hook feature, tape measure, [40](#)

zip ties

- cable weaving, [14–15](#)

- standing-off cables, [14](#)

- trimming excess tail, [96](#)